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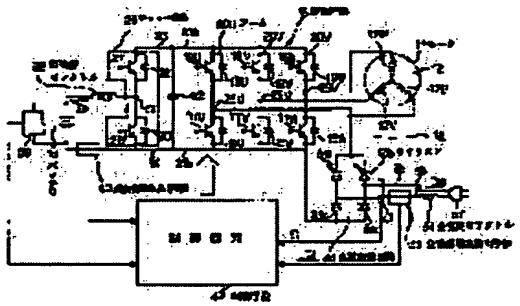
## (54) MOTOR DRIVING APPARATUS

(57)Abstract:
PURPOSE: To facilitate the driving and regenerative braking of a motor, the charge of a battery and the refreshment of the battery with a simple construction.
CONSTITUTION: A chopper circuit 26 is provided in parallel with an inverter circuit 15. When the power of an induction motor 11 is high, the chopper circuit 26 is made to function as a step-up chopper. When the induction motor 11 is in a regenerative operation, the chopper circuit 26 is made to function as a step-down chopper.



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CLAIMS

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[Claim(s)]
[Claim 1] It has one or more arms which come to connect with a serial two switching elements which have a fly wheel diode. The drive circuit which an input terminal is connected to a dc-battery, and an output terminal is connected to a motor, and carries out energization control of said motor by turning on and off of said switching element, The chopper circuit which comes to connect with a serial two switching elements which are connected to juxtaposition in this drive circuit, and have a fly wheel diode, The direct-current side reactor connected between the neutral point of this chopper circuit, and a dc-battery, It is prepared so that on-off control of the switching element of said drive circuit and a chopper circuit may be carried out. The driving gear of the motor which comes to provide the control means whose operation enables the operation of said chopper circuit as a chopper for pressure ups when supplying power to a drive circuit from said dc-battery, and is enabled as a chopper for pressure lowering when supplying power to a dc-battery from said drive circuit.
[Claim 2] A control means is the driving gear of the motor according to claim 1 characterized by controlling to supply the reference voltage of a dc-battery to a drive circuit when a motor output is low, and to make a chopper circuit act as a chopper for pressure ups when a motor output is high.
[Claim 3] A control means is the driving gear of the motor according to claim 1 characterized by being constituted so that a chopper circuit may be made to act as a chopper for pressure lowering at the time of the regeneration of a motor when a motor generation-of-electrical-energy electrical potential difference is higher than battery voltage, the charging current to a dc-battery may be controlled, it may be made to act as a chopper for pressure ups by carrying out on-off control of the negative side switching element of the arm of a drive circuit when a motor generation-of-electrical-energy electrical potential difference is lower than battery voltage and the charging current to a dc-battery may be controlled.
[Claim 4] While having a full wave rectifier circuit for carrying out full wave rectification of the external AC power supply and connecting the ac side reactor to the alternating current input terminal side A forward side direct-current output terminal attains to the neutral point of one arm of a drive circuit, and a negative side direct-current output terminal is connected to the negative terminal of a dc-battery. A control means The driving gear of the motor according to claim 1 characterized by being constituted so that it may be made to act as a chopper for pressure ups by carrying out on-off control of the negative side switching element of said one arm at the time of charge of the dc-battery by external AC power supply.
[Claim 5] It is the driving gear of the motor according to claim 4 characterized by having an ac side current detection means to detect the charging current which flows in a drive circuit through a full wave rectifier circuit from AC power supply, constituting the full wave rectifier circuit including two or more thyristors, and constituting the control means so that the energization phase of said thyristor may be controlled based on the detection current of said ac side current detection means to become size from abbreviation 0 gradually.
[Claim 6] It is the driving gear of the motor according to claim 4 characterized by having a direct-current side current detection means to detect the charging current which flows to a dc-battery, and constituting the control means so that the on-off duty of the chopper for pressure lowering may be gradually raised based on the detection current of the direct-current side current detection means and the charging current may be controlled to a predetermined value.
[Claim 7] A control means is the driving gear of the motor according to claim 6 characterized by being constituted so that the on-off duty of the chopper for pressure ups may be adjusted and the charging current may be controlled, when the detection current of a direct-current side current detection means does not reach a predetermined value.
[Claim 8] The driving gear of the motor according to claim 5 characterized by connecting the switching circuit which comes to connect with a serial two switching elements which have a fly wheel diode in a drive circuit at juxtaposition, and using the bidirectional triode thyristor instead of being a full wave rectifier circuit.
[Claim 9] A control means is the driving gear of the motor according to claim 4 characterized by being constituted so that it may control to make the alternating current which flows from external AC power supply follow the reference signal of the sine wave which synchronized with the AC-power-supply electrical potential difference.
[Claim 10] It is the driving gear of the motor according to claim 9 which a capacitor is connected to juxtaposition in a drive circuit, and is characterized by constituting the control means so that the electrical potential difference between terminals of a capacitor becomes beyond the peak value of an external AC-power-supply electrical potential difference and it may control.
[Claim 11] A control means is the driving gear of the motor according to claim 9 or 10 characterized by being constituted so that a chopper circuit may be made to act as a chopper for pressure lowering and current limiting may be performed, when the electrical potential difference between terminals of a capacitor is higher than the charge electrical potential difference of a dc-battery.
[Claim 12] The driving gear of the motor according to claim 2 by which reference voltage of a dc-battery is characterized by being constituted so that it may be impressed by the motor in the condition that the PWM duty of a drive circuit becomes 100% in the output for which a motor is used most frequently.
[Claim 13] A control means is the driving gear of the motor according to claim 8 characterized by being constituted so that external AC power supply may be made to revive the residual energy of the dc-battery at the time of refresh actuation of a dc-battery by carrying out on-off control of one arm of a drive circuit, and the switching element of a switching circuit.
[Claim 14] A chopper circuit is the driving gear of the motor according to claim 1 to 13 characterized by consisting of transistor modules which consist of two transistors which have a fly wheel diode in juxtaposition.
[Claim 15] A motor is the driving gear of the motor according to claim 1 to 14 characterized by using Rota constituted with the permanent magnet which comes to contain iron.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the driving gear of the motor which changes the direct current power of a dc-battery into alternating current power by the drive circuit, and was supplied to the motor.
[0002]
[Description of the Prior Art] For example, the conventional example of the driving gear which drives the motor of an electric vehicle is shown in drawing 10 . That is, while the direct-current bus-bars 2 and 3 are connected to forward [ of a dc-battery 1 ] and the negative terminal which consist of a nickel system cell (a nickel hydoride battery, nickel cadmium cell), between this direct-current bus-bar 2 and 3, the inverter circuit 6 which comes to carry out bridge connection of six transistor 4U 4W and 5U thru/or 5W is connected, and the output terminal of that inverter circuit 6 is connected to the input terminal of a motor 7. In this case, since the direct current voltage of a dc-battery 1 is directly impressed to an inverter circuit 6, output (engine speed) control of a motor 7 is performed by carrying out PWM control of the inverter circuit 6.
[0003] Moreover, conventionally, if a dc-battery 1 discharges and an electrical potential difference descends, since power required to drive a motor 7 will no longer be obtained, in order to charge a dc-battery, the battery charger which consisted of rectification smoothing circuits which rectify and carry out smooth [ of the transformer which transforms the AC-power-supply electrical potential difference of external AC power supply, and the alternating voltage from this transformer ], and are made into direct current voltage is carried in the electric vehicle.
[0004] Furthermore, since it becomes impossible for the dc-battery 1 which consists of a nickel system cell to emit the charge power of the dc-battery 1 interior 100% by the memory effect, it makes the refresh actuation which makes the residual power of a dc-battery 1 discharge to the resistor for discharge until the electrical potential difference turns into a minimum electrical potential difference perform conventionally.
[0005]
[Problem(s) to be Solved by the Invention] The following technical problems which should be solved occurred with the above-mentioned conventional configuration.
(a) In an electric vehicle, on transit, although the maximum output needed for a motor 7 is large, the capacity of a motor 7 and an inverter circuit 6 is set up, corresponding to the maximum output with a stationary output is small and natural. In this case, in order to make a rotational frequency low by PWM control of an inverter circuit 6 at the time of the low-power output of a motor 7, it is necessary to make pulse width of PWM into smallness very much that applied voltage to a motor 7 should be made low, therefore many harmonic content will be contained in the applied voltage of a motor 7, the motor loss it is without a loss on a motor 7 mainly from iron loss with this harmonic content occurs, and the effectiveness at the time of steady operation worsens.
[0006] (b) although regeneration power is supplied from a motor 7 to a dc-battery 1 when a motor 7 changes from high power to low-power output -- the engine speed of the motor 7 at this time -- a motor generation-of-electrical-energy electrical potential difference -- battery voltage -- receiving -- ****** -- proper regenerative braking is not performed by **.
[0007] (c) Since the battery charger which has a transformer etc. for charge of a dc-battery 1 is required, a manufacturing cost increases, and since especially the battery charger containing a transformer needs a large installation tooth space, it is disadvantageous for an electric vehicle.
[0008] (d) Since it is necessary to prepare the resistor for discharge with it since a dc-battery 1 is refreshed and stripping of the residual power is carried out as the Joule's heat by the resistor for discharge, and especially the large-sized resistor for discharge needs a large installation tooth space, for an electric vehicle, it is disadvantageous. [ bad and energy efficiency and ] [ large-sized ]
[0009] This invention was made in view of the above-mentioned situation, and the 1st purpose is in offering the driving gear of the motor which can improve the effectiveness at the time of steady operation of a motor.
[0010] The 2nd purpose of this invention is to offer the driving gear of the motor which can perform regenerative braking smooth irrespective of the size of a motor generation-of-electrical-energy electrical potential difference at the time of regenerative braking of a motor.
[0011] The 3rd purpose of this invention is to offer the driving gear of the motor which does not need the battery charger of dedication for charge of a dc-battery.
[0012] The 4th purpose of this invention is to offer the driving gear of the motor which does not need the resistor for discharge at the time of refresh of a dc-battery.
[0013]
[Means for Solving the Problem] The driving gear of a motor according to claim 1 has one or more arms which come to connect with a serial two switching elements which have a fly wheel diode. The drive circuit which an input terminal is connected to a dc-battery, and an output terminal is connected to a motor, and carries out energization control of said motor by turning on and off of said switching element, The chopper circuit which comes to connect with a serial two switching elements which are connected to juxtaposition in this drive circuit, and have a fly wheel diode, The direct-current side reactor connected between the neutral point of this chopper circuit, and a dc-battery, It is prepared so that on-off control of the switching element of said drive circuit and a chopper circuit may be carried out. When supplying power to a drive circuit from said dc-battery, the operation of said chopper circuit is enabled as a chopper for pressure ups, and when supplying the power from said drive circuit to a dc-battery, it has the description in the configuration which comes to provide the control means whose operation is enabled as a chopper for pressure lowering.
[0014] The driving gear of a motor according to claim 2 supplies the reference voltage of a dc-battery for a control means to a drive circuit, when a motor output is low, and when a motor output is high, it has the description at the place considered as the configuration

controlled to make a chopper circuit act as a chopper for pressure ups.
[0015] The driving gear of a motor according to claim 3 has the description at the place constituted so that a chopper circuit may be made for a control means to act as a chopper for pressure lowering at the time of the regeneration of a motor when a motor generation-of-electrical-energy electrical potential difference is higher than battery voltage, the charging current to a dc-battery may be controlled, it may be made to act as a chopper for pressure ups by carrying out on-off control of the negative side switching element of the arm of a drive circuit when a motor generation-of-electrical-energy electrical potential difference is lower than battery voltage and the charging current to a dc-battery may be controlled.
[0016] While the driving gear of a motor according to claim 4 is equipped with the full wave rectifier circuit for carrying out full wave rectification of the external AC power supply and connecting an ac side reactor to the alternating current input terminal side Connect a forward side direct-current output terminal at the neutral point of one arm of a drive circuit, and connect a negative side direct-current output terminal to the negative terminal of a dc-battery, and a control means at the time of charge of the dc-battery by external AC power supply It has the description at the place constituted so that it may be made to act as a chopper for pressure ups by carrying out on-off control of the negative side switching element of said one arm.
[0017] The driving gear of a motor according to claim 5 has the description at the place which is equipped with an ac side current detection means to detect the charging current which flows in a drive circuit through a full wave rectifier circuit from AC power supply, constitutes the full wave rectifier circuit including two or more thyristors, and constitutes a control means based on the detection current of said ac side current detection means so that it may control to become size from abbreviation 0 gradually about the energization phase of said thyristor.
[0018] The driving gear of a motor according to claim 6 is equipped with a direct-current side current detection means to detect the charging current which flows to a dc-battery, and has the description at the place constituted so that the charging current may be controlled to a predetermined value by raising gradually the on-duty of the chopper circuit which acts a control means as a chopper for pressure lowering based on the detection current of the direct-current side current detection means.
[0019] The driving gear of a motor according to claim 7 has the description at the place considered as the configuration which adjusts the on-off duty of a pressure-up chopper, and controls the charging current, when the detection current of a direct-current side current detection means does not reach a predetermined value in a control means.
[0020] The driving gear of a motor according to claim 8 connects the switching circuit which comes to connect with a serial two switching elements which have a fly wheel diode in a drive circuit at juxtaposition, and it has the description in the configuration which a bidirectional triode thyristor uses instead of a full wave rectifier circuit.
[0021] it have the description at the place constitute so that power-factor control may be perform , as the electrical potential difference between terminals of said capacitor become beyond the peak value of an AC power supply electrical potential difference by the driving gear of a motor claim 9 and given in ten connect a capacitor to juxtaposition in a drive circuit , and control to make the alternating current which flow a control means from external AC power supply follow the reference signal of the sine wave which synchronized with the AC power supply electrical potential difference .
[0022] The driving gear of a motor according to claim 11 has the description at the place constituted so that a chopper circuit may be made for a control means to act as a chopper for pressure lowering when the electrical potential difference between terminals of a capacitor is higher than the charge electrical potential difference of a dc-battery, and current limiting may be performed.
[0023] The PWM duty of a drive circuit has the description at the place constituted so that the driving gear of a motor according to claim 12 might be impressed to a motor in the condition that the reference voltage of a dc-battery becomes 100% in the output for which a motor is used most frequently.
[0024] The driving gear of a motor according to claim 13 has the description at the place constituted so that external AC power supply may be made to revive the residual energy of the dc-battery at the time of refresh actuation of a dc-battery by carrying out on-off control of one arm of a drive circuit, and the switching element of a switching circuit for a control means.
[0025] The driving gear of a motor according to claim 14 has the description at the place which constitutes a chopper circuit from a transistor module which consists of two transistors which have a fly wheel diode in juxtaposition.
[0026] The driving gear of a motor according to claim 15 has the description to use Rota constituted with the permanent magnet which comes to contain iron in a motor.
[0027]
[Function] Since according to the driving gear of a motor claim 1 and given in two it can act by making a chopper circuit into the chopper for pressure ups when supplying power to a motor through a drive circuit from a dc-battery, it can become possible to impress an electrical potential difference higher than battery voltage to a motor, and a motor can be made to drive at a rotational frequency higher than the time of a stationary. Moreover, even if a motor generation-of-electrical-energy electrical potential difference or an external power electrical potential difference is higher than battery voltage when carrying out regenerative braking of the motor, or when charging a dc-battery from an external power since it can act by making a chopper circuit into the chopper for pressure lowering when supplying power to a dc-battery from a drive circuit, a dc-battery can be charged, without damaging a circuit element.
[0028] According to the driving gear of a motor according to claim 3, at the time of regenerative braking of a motor, when a motor generation-of-electrical-energy electrical potential difference is lower than battery voltage, the arm comes to act as a chopper for pressure ups by carrying out on-off control of the negative side switching element of the arm of a drive circuit.
[0029] According to the driving gear of a motor according to claim 4, at the time of charge of a dc-battery, while full wave rectification of the external AC power supply is carried out by the full wave rectifier circuit, one arm acts as a chopper for pressure ups, the pressure up of the full-wave-rectification electrical potential difference comes to be carried out, therefore even when an AC-power-supply electrical potential difference is lower than battery voltage, charge of a dc-battery is attained.
[0030] According to the driving gear of a motor according to claim 5, since a control means controls the energization phase of the thyristor of a full wave rectifier circuit based on the detection current of an ac side current detection means to become size from abbreviation 0 gradually, it can control the rush current at the time of charge initiation.
[0031] According to the driving gear of a motor according to claim 6, a control means can control the charging current to a predetermined value, and can make the stable charge perform at the time of charge of a dc-battery, since the on-duty of the chopper circuit which acts as a chopper for pressure lowering based on the detection current of a direct-current side current detection means is raised gradually.
[0032] According to the driving gear of a motor according to claim 7, at the time of charge of a dc-battery, since a control means adjusts the on-off duty of the chopper for pressure ups and controls the charging current when the detection current of a direct-current side current detection means does not reach a predetermined value, it does so the same effectiveness as claim 6.
[0033] According to the driving gear of a motor according to claim 8, even if it prepares a switching circuit and a bidirectional 3 terminal thyristor, the same operation effectiveness as claim 5 is acquired. Since power factor improvement can be aimed at since the

current which flows from external AC power supply to a reference signal is made to follow according to the driving gear of a motor given in claims 9 and 10, and a capacitor is charged at the electrical potential difference beyond the peak value of an AC-power-supply electrical potential difference, it is controllable so that the charging current of a dc-battery becomes fixed according to an operation with the chopper for pressure lowering.

[0034] According to the driving gear of a motor according to claim 11, since a chopper circuit is made to act as a chopper for pressure lowering also when the electrical potential difference between terminals of a capacitor is higher than the charge electrical potential difference of a dc-battery, the same effectiveness as claim 10 is acquired.

[0035] According to the driving gear of a motor according to claim 12, since the PWM duty of a drive circuit is impressed to a motor in the condition that the reference voltage of a dc-battery becomes 100% in the output for which a motor is used most frequently, it can design a motor and a drive circuit according to a stationary output.

[0036] According to the driving gear of a motor according to claim 13, since AC power supply is made to revive the residual energy at the time of refresh actuation of a dc-battery, energy efficiency becomes good and the resistor for discharge becomes unnecessary. According to the driving gear of a motor according to claim 14, since the chopper circuit was constituted from a transistor module, a configuration becomes easy.

[0037] According to the driving gear of a motor according to claim 15, even if it uses Rota constituted with the permanent magnet which comes to contain iron in a motor, the temperature rise by the iron loss of Rota can be controlled.

[0038]

[Example] Hereafter, it explains about the 1st example which applied this invention to the electric vehicle, referring to drawing 1 thru/or drawing 5 . In drawing 1 which shows a whole configuration, the induction motor 11 is carried in the electric vehicle as a motor for transit, and this is equipped with the stator 12 which has the stator coils 12U, 12V, and 12W of two or more phases, for example, a three phase circuit, and Rota which is not illustrated. Moreover, the dc-battery 13 which consists of a nickel system cell and which can be charged is carried in the electric vehicle, and the DC power supply from this dc-battery 13 are changed into AC power supply by dc-battery charging equipment and dc-battery refresh equipment combination motorised equipment 14, and are supplied to said induction motor 11 by them.

[0039] Now, it states about the concrete configuration of dc-battery charging equipment and dc-battery refresh equipment combination motorised equipment 14. Three-phase-circuit bridge connection of the transistors 16U, 16V, and 16W of a six switching element slack NPN form, and 17U, 17V and 17W was carried out, it was constituted, and fly wheel diodes 18U, 18V, and 18W, and 19U, 19V and 19W are connected between each collector and an emitter, with the inverter circuit 15 as a drive circuit has three arms 20U, 20V, and 20W. And the input terminals 21a and 21b of this inverter circuit 15 are connected to the direct-current bus-bars 23 and 24 to which the capacitor 22 was connected between lines, and output terminals 25U, 25V, and 25W are connected to one terminal each of the stator coils 12U, 12V, and 12W of an induction motor 11. In addition, each other end child of stator coils 12U, 12V, and 12W is connected in common.

[0040] A chopper circuit 26 is what consisted of transistor modules which have the transistors 27 and 28 and fly wheel diodes 29 and 30 of an NPN form as a switching element. A collector is connected to the direct-current bus-bar 23 in the transistor 27. The emitter is connected to the collector of a transistor 28, the emitter of the transistor 28 is connected to the direct-current bus-bar 24, and diodes 29 and 30 are connected between each collector of transistors 27 and 28, and an emitter. And the neutral point slack AC-power-supply terminal 31 of a chopper circuit 26 is connected to the positive terminal of a dc-battery 13 through the direct-current side reactor 32, and the negative terminal of a dc-battery 13 is connected to the direct-current bus-bar 24.

[0041] Neutral point slack output terminal 25of one arm 20U of inverter circuit 15 U is connected to the honest outflow force terminal of a full wave rectifier circuit 33, and the negative direct-current output terminal of the full wave rectifier circuit 33 is connected to the direct-current bus-bar 24 (negative terminal of a dc-battery 3). In this case, the full wave rectifier circuit 33 carried out bridge connection of the two diodes 33c and 33d to two thyristors 33a and 33b, it was constituted, and that alternating current input terminal is connected to the attachment plug 37 through AC-power-supply Rhine 35 and 36 which inserted the ac side reactor 34 in one side.

[0042] It connects between forward [ of a dc-battery 13 ], and a negative terminal, and the direct-current-voltage detector 38 detects the electrical potential difference between terminals of a dc-battery 13. The ac side current detection means slack alternating current detector 39 is arranged in AC-power-supply Rhine 36, and detects the current (current which flows to a reactor 34 so that it may mention later) which flows to AC-power-supply Rhine 36. The direct-current side current detection means slack charging current detector 40 is arranged by the direct-current bus-bar 24, and detects the charging current which flows to a dc-battery 13. In addition, the alternating current detector 39 and the charging current detector 40 are constituted by the hall device form current transformer which can detect both alternating current and a direct current. The zero crossing point sensor 41 which consists of a photo coupler is formed between DC-power-supply Rhine 35 and 36.

[0043] Now, the control means slack control circuit 42 was constituted considering the microcomputer as a subject, each output terminal of the direct-current-voltage detector 38, the alternating current detector 39, the charging current detector 40, and the zero crossing point sensor 41 is connected to each of that input port, and each output port is connected to the base (gate) of the transistors 27 and 28 of transistor 16U of an inverter circuit 15 16W and 17U thru/or 17W, and a chopper circuit 26, respectively. In addition, although two output ports of a microcomputer 42 do not carry out illustration, they are connected to the gate of the thyristors 33a and 33b of a full wave rectifier circuit 33.

[0044] Next, also with reference to drawing 2 thru/or drawing 5 R> 5, it explains about an operation of this example.

(1) Describe the actuation at the time of transit of drive place ** of an induction motor 11, and an electric vehicle. That is, a control circuit 42 creates the energization timing signal over transistor 16U of an inverter circuit 15 16W and 17U thru/or 17W, gives a base signal (gate signal) to transistor 16U 16W and 17U thru/or 17W in predetermined sequence according to the energization timing signal, and carries out on-off control of transistor 16U 16W and 17U thru/or 17W. Thereby, in an inverter circuit 15, alternating voltage is created from the direct current voltage of a dc-battery 13, it comes to give an induction motor 11, an induction motor 11 rotates, and an electric vehicle runs.

[0045] As a motor rating here at the time of a stationary (the rotational frequency and torque which are used frequently) 160 (V), When it carried out to 10 (kW) (N-m), 5000 (rpm) and 20, and 320 (V) and 40 (kW) (N-m), 10000 (rpm) and 40, are required at the time of the maximum output, as an induction motor 11 [ i.e., ] [ i.e., ] As shown in drawing 2 , the thing of 5000 (rpm) and 20 (N-m) is prepared, and the thing of 160 (V) is selected as a dc-battery 13.

[0046] In rotating an induction motor 11 with slack 5000 (rpm) at the time of a stationary, a control circuit 42 becomes having made the transistors 27 and 28 of a chopper circuit 26 turn off with as. Therefore, a capacitor 22 is charged so that the electrical potential difference between terminals may turn into battery voltage 160 (V), and this is impressed to an inverter circuit 15. And although a control circuit 42 comes to carry out on-off control of transistor 16U of an inverter circuit 15 16W and 17U thru/or 17W so that an induction motor 11 may rotate by 5000 (rpm), it sets the PWM duty at this time as 100 (%). Therefore, the electrical potential

difference impressed to an induction motor 11 is set to 160 (V).
[0047] In rotating an induction motor 11 at an engine speed lower than 5000 (rpm), it controls a control circuit 42 by carrying out PWM control of transistor 16U of an inverter circuit 15 thru/or 16W or 17U thru/or 17W so that the electrical potential difference impressed to an induction motor 11 turns into a low electrical potential difference according to the engine speed.
[0048] When rotating an induction motor 11 at an engine speed higher than 5000 (rpm), a control circuit 42 makes the transistor 28 of a chopper circuit 26 turn on first. Thereby, electromagnetic energy is accumulated when a current flows to a reactor 32 in the path of the positive terminal of a dc-battery 13, a reactor 32, a transistor 28, and the negative terminal of a dc-battery 13. Then, a control circuit 42 comes to turn off the transistor 28 of a chopper circuit 26, the electromagnetic energy accumulated in the reactor 32 is accumulated in a capacitor 22 through a fly wheel diode 29, and the electrical potential difference between terminals of a capacitor 22 turns into a high electrical potential difference from 160 (V).
[0049] For example, by controlling the on-off duty of the transistor 28 of a chopper circuit 26, in setting the engine speed of an induction motor 11 to 7500 (rpm), it carries out a pressure up so that the electrical potential difference between terminals of a capacitor 22 may be set to 240 (V). moreover, the engine speed of an induction motor 11 -- the maximum output -- in making it alike 10000 (rpm), similarly it carries out a pressure up by controlling the on-off duty of the transistor 28 of a chopper circuit 26 so that the electrical potential difference between terminals of a capacitor 22 may be set to 320 (V).
[0050] That is, a chopper circuit 26 controls a control circuit 42 to set transistor 16U of an inverter circuit 15 thru/or 16W or 17U thru/or PWM duty of 17W to 100 (%), while it acts as a chopper for pressure ups and this chopper circuit 26 is acting as a chopper for pressure ups. Therefore, the electrical potential difference between terminals of the capacitor 22 by which the pressure up was carried out in the chopper circuit 26 comes to be impressed to an induction motor 11 through an inverter circuit 15.
[0051] (2) When the regenerative-braking induction motor 11 of an induction motor 11 shifts to low-power output (low rotational frequency) from high power (high rotational frequency), an induction motor 11 serves as regenerative braking. That is, a control circuit 42 comes to make the transistor 27 of a chopper circuit 26 turn on, therefore the regeneration current from an induction motor 11 comes to flow to a dc-battery 13 through the transistor 27 of a chopper circuit 26 at fly wheel diode 18U of an inverter circuit 15 18W and 19U thru/or 19W list.
[0052] In this case, since the generation-of-electrical-energy electrical potential difference of an induction motor 11 comes to be proportional to the engine speed at this time, a motor generation-of-electrical-energy electrical potential difference becomes higher than 160 (V) of battery voltage. Then, at the time of this regenerative braking, a control circuit 42 makes the transistor 27 of a chopper circuit 26 turn off, when the charging current detector 40 detects the charging current (regeneration current) Ib over a dc-battery 13 and this exceeds a predetermined value, and conversely, when the charging current Ib is below a predetermined value, it is controlled to make a transistor 27 turn on. Therefore, a chopper circuit 26 comes to act as a chopper for pressure lowering in this case.
[0053] In addition, at the time of regenerative braking of an induction motor 11, when the generation-of-electrical-energy electrical potential difference of an induction motor 11 is lower than the charge electrical-potential-difference slack 160 of a dc-battery 13 (V), a control circuit 42 makes arm 20U of an inverter circuit 15 transistor 17U of one negative side of 20W thru/or 17W turn on, and carries out the pressure up of the electrical potential difference which repeats making transistor 17U thru/or 17W turn off after that, and is supplied to a dc-battery 13 from an inverter circuit 15. Therefore, an inverter circuit 15 comes to act as a chopper for pressure ups.
[0054] (3) If the charge dc-battery 13 of a dc-battery 13 discharges and an electrical potential difference descends, since power required to drive an induction motor 11 will no longer be obtained, charge a dc-battery 13 from external AC power supply in this case. That is, if an attachment plug 37 is inserted in the source-power-supply slack power receptacle (not shown) of 100 (V) as external AC power supply and it connects, a control circuit 42 will switch to charge mode automatically, and one arm 20U and a chopper circuit 26, and full wave rectifier circuit 33 of an inverter circuit 15 will be used for it in this charge mode.
[0055] That is, if an attachment plug 37 is inserted and connected to a power receptacle, as drawing 4 R> 4 (a) and drawing 5 (a) show, the AC-power-supply electrical potential difference Vac is supplied and drawing 5 (b) shows, the zero crossing point sensor 41 will output the output signal S of a square wave which becomes high-level by the low level and the negative(-) half wave by the forward (+) half wave, and will give this to a control circuit 42. When it detects that the output signal S from the zero crossing point sensor 41 repeats a low level and high level, a control circuit 42 judges that it is charge initiation, and makes transistor 17U of one arm of inverter circuit 15 20U and transistor 16U other than transistor 27 of a chopper circuit 26 thru/or 16W, and 17V and 17W turn off. Furthermore, a control circuit 42 detects the zero crossing point of the AC-power-supply electrical potential difference Vac from the standup and fall of an output signal S from the zero crossing point sensor 41, as shown in drawing 5 (b).
[0056] If the zero crossing point of the AC-power-supply electrical potential difference Vac is detected, a control circuit 42 will create the criteria (electrical potential difference) signal VR of the sine wave which synchronized with the AC-power-supply electrical potential difference Vac by PLL control based on this, as shown in drawing 5 (c). A control circuit 42 judges the polarity of the AC-power-supply electrical potential difference Vac from a reference signal VR, and performs the following control based on this.
[0057] A control circuit 42 starts initial charge actuation, when it is judged as charge by external AC power supply. That is, a control circuit 42 makes the transistor 27 of a chopper circuit 26 turn on, and makes transistor 17of one arm 20U U turn on in the both sides of the forward (+) half wave of the AC-power-supply electrical potential difference Vac, and the negative(-) half wave. First, a control circuit 42 serves as abbreviation 0, as the AC-power-supply electrical potential difference Vac (refer to drawing 4 (a)) comes to give a gate signal to thyristor 33b of a full wave rectifier circuit 33 near the zero crossing point from a negative half wave to a forward half wave, therefore the energization phase of thyristor 33b is shown in drawing 4 (b). Then, a control circuit 42 comes to control the gate signal given to the thyristors 33a and 33b so that the energization phase of Thyristors 33a and 33b may become size gradually to be shown in drawing 4 (b).
[0058] In the period which it ** and thyristor 33a or 33b turns on If a current will flow to a reactor 34, electromagnetic energy will be accumulated in a reactor 34, and a gate signal will not be given to thyristor 33a or 33b and transistor 17U turns off synchronizing with the gate signal As the electromagnetic energy comes to be given to a dc-battery 13 through a capacitor 22, and it comes to charge on the electrical potential difference to which the pressure up of the dc-battery 13 was carried out, therefore the AC-power-supply current Iac of external AC power supply is shown in drawing 4 (c), it increases gradually. In addition, the principle of the charge over a dc-battery 13 is explained in full detail behind. By the charging current Ib over a dc-battery 13 being detected by the charging current detector 40, and giving a control circuit 42, a control circuit 42 will shift to the next usual charge actuation, if the charging current Ib reaches a predetermined value.
[0059] That is, when the AC-power-supply electrical potential difference Vac is the forward (+) half wave, a control circuit 42 makes transistor 17of one arm 20U of inverter circuit 15 U turn on, and makes thyristor 33b of a full wave rectifier circuit 33 turn on first. Thereby, the AC-power-supply current Iac flows to a reactor 34 in the path of thyristor 33b, transistor 17U, diode 33c, and a reactor 34, and electromagnetic energy is accumulated in a reactor 34. The AC-power-supply current Iac which flows to this reactor 34 is detected by the alternating current detector 39, and is given to a control circuit 42 as a detection current Id. In addition, in fact, the

detection current Id is described as the expedient top of explanation, and a detection current Id here, although it is changed into an electrical potential difference and a control circuit 42 is given.
[0060] When the detection current Id increases by continuation of the ON state of transistor 17U and this becomes size from a reference signal VR, a control circuit 42 makes transistor 17U turn off, and makes a transistor 27 turn on. Thereby, the electromagnetic energy accumulated in the reactor 34 is given to a capacitor 22 through thyristor 33b and fly wheel diode 18U, further, comes to be given to a dc-battery 13 through a transistor 27, and is charged on the electrical potential difference to which the pressure up of the dc-battery 13 was carried out.
[0061] Then, when the detection current Id of the alternating current detector 39 decreases and it becomes smallness from a reference signal VR, it comes to make transistor 17U, as for a control circuit 42, turn on again. Hereafter, it comes to repeat the same actuation. Therefore, the gate signal Sy given to transistor 17U comes to be shown in drawing 5 (d).
[0062] When the AC-power-supply electrical potential difference Vac is the negative(-) half wave, a control circuit 42 makes transistor 17of one arm 20U U turn on, and makes thyristor 33a turn on. The on-off control action of the transistors 17U and 27 in this case is the same as that of the above-mentioned. Therefore, the gate signal Sz given to transistor 17U comes to be shown in drawing 5 (e).
[0063] That is, as shown in drawing 5 (f), a control circuit 42 carries out on-off control of the transistor 17U so that the detection current Id may follow a reference signal VR, and thereby, the detection current Id is controlled by the wave of the shape of a sine wave of the AC-power-supply electrical potential difference Vac and an inphase, and it comes to show the AC-power-supply current Iac to drawing 5 (g).
[0064] The annunciator which will judge a control circuit 42 to be the completion of charge, it will make turn off transistors 17U and 27 and Thyristors 33a and 33b, and will not illustrate it if the electrical potential difference between terminals of a dc-battery 13 reaches default value is operated by **(ing), and the electrical potential difference between terminals of a dc-battery 13 being detected by the direct-current-voltage detector 38, and giving a control circuit 42, and the completion of charge is reported.
[0065] Thus, since according to this example a chopper circuit 26 is made to act as a chopper for pressure ups and it was made to carry out PWM control of the inverter circuit 15 when driving an induction motor 11, as an induction motor 11, it can be made rating at the time of steady operation, and effectiveness can be improved. Moreover, since a chopper circuit 26 is made to act as a chopper for pressure lowering according to the generation-of-electrical-energy electrical potential difference of an induction motor 11 or it was made to make an inverter circuit 15 act as a chopper for pressure ups at the time of regenerative braking of an induction motor 11, regenerative braking of an induction motor 11 can be performed smoothly.
[0066] Furthermore, at the time of charge of a dc-battery 13, external AC power supply is connected through a reactor 34 between the negative terminals of the output terminal 25U and the dc-battery 13 of one arm 20U of the drive circuit slack inverter circuit 15. Since it was made to carry out on-off control of the both sides of transistors 17U and 27 A current flows from external AC power supply intermittently to a reactor 34, electromagnetic energy is accumulated, the electromagnetic energy is given to a dc-battery 13 through one arm 20U and a chopper circuit 26, and this comes to be charged.
[0067] Therefore, even if it does not use the battery charger of the dedication which has the transformer which are weight and the volume, and which becomes size unlike the former A chopper circuit 26 can be ****ed and a dc-battery 13 can be charged only by control of a control circuit 42. Only the part can aim at reduction of a manufacturing cost, and can attain small lightweight-ization of the loading object in the machine room of an electric vehicle. Since only **** and the part which attained small lightweight-ization can carry many numbers of a dc-battery 13 conversely, lengthening 1 charge mileage can lengthen 1 charge mileage. Moreover, even if it receives the dc-battery 13 of 160 (V) rating and a twist is also the external power of a low electrical potential difference or a high electrical potential difference, the dc-battery 13 can be charged easily and it is very advantageous to a user.
[0068] Furthermore, when an external power was AC power supply at the time of charge of a dc-battery 13, the control circuit 42 detected the zero crossing point of the AC-power-supply electrical potential difference Vac based on the output signal of the zero crossing point sensor 41, and the reference signal VR which synchronized with the AC-power-supply electrical potential difference Vac based on this is acquired, and it was made to make the detection current Id of the alternating current detector 39 which detects the AC-power-supply current Iac to this reference voltage VR follow.
[0069] Therefore, even if it uses the reactor 34 for pressure ups, power factor improvement of AC power supply can be controlled, reduction of a power-source higher harmonic wave can be aimed at, and control of the charging current over a dc-battery 13 can also be performed to coincidence.
[0070] Moreover, since it was made for a control circuit 42 to make the initial charge actuation which controls the energization phase of thyristor 33a of the full wave rectifier circuit 33 established in the charge way of a dc-battery 13 at the time of charge of a dc-battery 13, or 33b to become size from abbreviation 0 gradually perform, it can prevent the rapid charge over a dc-battery 13, and does not have a bad influence on a dc-battery 13.
[0071] In addition, in the above-mentioned example, at the time of charge of a dc-battery 13, a capacitor 22 is charged at the electrical potential difference (for example, 300 (V)) more than the battery voltage slack 160 (V), the transistor 27 of a chopper circuit 26 is adjusted in the on-off duty based on the detection current of the alternating current detector 39 or the charging current detector 40, and it may be made to make the charging current of a dc-battery 13 regularity at it.
[0072] Drawing 6 and drawing 7 are the 2nd example of this invention, attach and show the same sign to the same part as drawing 1 , and explain only a different part to it hereafter. That is, between the direct-current bus-bar 23 and 24, the switching circuit 43 is connected, and this switching circuit 43 connects to a serial the transistors 44 and 45 of the switching element slack NPN form where it has fly wheel diodes 46 and 47 in juxtaposition, and is constituted. And neutral point slack output terminal 25of one arm 20U of inverter circuit 15 U is connected to AC-power-supply Rhine 35 through a bidirectional triode thyristor (a triac is called hereafter) 48, and the neutral point slack AC-power-supply terminal 48 of a switching element 43 is connected to AC-power-supply Rhine 36.
[0073] In drawing 7 , warm 49b is formed in revolving-shaft 49a of DC motor 49, worm gear 50a which gears with the warm 49b is prepared, the contact surfaces 50b and 50c of the traveling contact plate 50 attach and detach by the vertical movement to the contact surfaces 51a and 52a of the stationary-contact plates 51 and 52, and the contactor 53 is constituted by the traveling contact plate 50 by the above at it.
[0074] And the positive terminal of the DC-power-supply slack cell 54 is connected to the fixed contact piece a of a change-over switch 55, and the fixed contact piece b of a change-over switch 56, the negative terminal of a cell 54 is connected to the fixed contact piece b of a change-over switch 55, and the fixed contact piece a of a change-over switch 56, and the movable contact pieces c and c of change-over switches 55 and 56 are connected to the input terminal of DC motor 49.
[0075] Again, in drawing 6 , the stationary-contact plate 51 of a contactor 53 is connected to the positive terminal of a dc-battery 13, and the stationary-contact plate 52 is connected to the dc-battery side edge child of the direct-current side reactor 32.
[0076] Except that it ** and a triac 48 comes to carry out instead of the thyristors 33a and 33b of a full wave rectifier circuit 33 about

actuation of charge of the drive of an induction motor 11, and the regenerative-braking list of an induction motor 11 of a dc-battery 22, it is the same as that of the 1st example.
[0077] (4) Make it operate and turn on the refresh switch which inserts an attachment plug 37 at the AC-power-supply slack power receptacle of 100 volts of single phase, connects, and is not illustrated at this time to describe refresh of a dc-battery 13, now refresh actuation of a dc-battery 13. Thereby, a control circuit 42 switches from the drive mode of an induction motor 11 to the refresh mode of a dc-battery 13.
[0078] It will output an output signal S, and if an attachment plug 37 is connected to a power receptacle, as mentioned above, thereby, the zero crossing point sensor 41 creates the criteria (electrical potential difference) signal VR of a sine wave with which the control circuit 42 synchronized with the AC-power-supply electrical potential difference Vac as PLL control showed to drawing 5 (c), and a control circuit 42 will judge the polarity of the AC-power-supply electrical potential difference Vac from a reference signal VR, and it will perform the following control based on this.
[0079] In refresh mode, one arm 20U and a switching circuit 43, and triac 48 of an inverter circuit 15 are used for a control circuit 42. That is, a control circuit 42 makes the transistor 45 of one transistor 16U and the switching circuit 43 of arm 20U turn on first, when the AC-power-supply electrical potential difference Vac is the forward (+) half wave, while making a triac 48 turn on. Thereby, alternating current (the discharge current of a dc-battery 13, regeneration current to AC power supply) flows in the path of the positive terminal of a dc-battery 13, a contactor 53, diode 29, transistor 16U, a triac 48, a plug socket 37 (AC power supply), a reactor 34, a transistor 45, and the negative terminal of a dc-battery 13, and this is detected by the alternating current detector 39 and given to a control circuit 42 as a detection current.
[0080] When a detection current increases by continuation of the ON state of transistors 16U and 45 and this serves as size from a reference signal VR, a control circuit 42 makes transistor 16U turn off. Then, when the detection current of the alternating current detector 39 decreases and it becomes smallness from a reference signal VR, it comes to make transistor 16U, as for a control circuit 42, turn on again. Hereafter, it comes to repeat the same actuation.
[0081] A control circuit 42 makes the transistor 44 of a switching circuit 43 turn on, when the AC-power-supply electrical potential difference Vac is the negative(-) half wave while making transistor 17of one arm 20U U turn on. The on-off control action of the transistor 44 in this case is the same as that of the above-mentioned transistor 16U.
[0082] According to the 2nd example, thus, at the time of refresh actuation of a dc-battery 13 By the chopper for pressure lowering formed of one arm 20U and the switching circuit 43 of an inverter circuit 15, since the residual power (residual energy) of a dc-battery 13 was revived to external AC power supply Unlike the former, it becomes impossible to carry out stripping as the Joule's heat using the resistor for discharge, and can aim at an improvement of energy efficiency so much, and since the resistor for discharge is unnecessary It is not necessary to secure the installation tooth space in an electric vehicle, and is the the best for the narrow electric vehicle of an installation tooth space.
[0083] in addition, in demounting a dc-battery 13 from an electric vehicle For example, by making between the contact pieces (c-a) of change-over switches 55 and 56 turn on, and making an one direction rotate DC motor 49 As the traveling contact plate 50 is raised and it is shown in drawing 7 R> 7, in making a contactor 53 turn off and installing a dc-battery 13 in an electric vehicle conversely The traveling contact plate 50 is dropped and a contactor 53 is made to turn on by making between the contacts (c-b) of change-over switches 55 and 56 turn on, and making hard flow rotate DC motor 49. Thereby, a contactor 53 can be made with the stable switching means which does not have a chattering by vibration etc.
[0084] Drawing 8 and drawing 9 are the 3rd example of this invention, attach and show the same sign to the same part as drawing 1 , and explain a different part to it hereafter. That is, in this 3rd example, it is what used the brushless motor 57 as a motor, and the brushless motor 57 consists of Rota (not shown) of the permanent magnet form using the stator 58 which has the stator coils 58U, 58V, and 58W of two or more phases, for example, a three phase circuit, and the magnetic substance containing iron, for example, the magnetic substance which consists of neodium-iron-boron (Nd-Fe-B). And the star of the stator coils 58U, 58V, and 58W is carried out, and the one terminal each is connected to the output terminals 25U, 25V, and 25W of an inverter circuit 15.
[0085] It **, three location sensing elements which consist of hall devices which detect the rotation location of Rota as everyone knows are prepared in the brushless motor 57, and a control circuit 42 creates the energization timing signal over transistor 16U of an inverter circuit 15 16W and 17U thru/or 17W by carrying out logical operation of the location detecting signal from these location sensing elements. The effectiveness as said 1st example that actuation of others of a control circuit 42 is the same as that of the 1st example, therefore it is the same even when a brushless motor 57 is used as a drive motor of an electric vehicle can be acquired. By the way, when Rota of a brushless motor 57 is constituted from a permanent magnet using the magnetic substance which consists of Nd-Fe-B, there is an advantage to which coercive force can make it it is efficient and long lasting since this kind of permanent magnet is expensive.
[0086] In this case, in the conventional example, if the thing same as that Rota as Rota of the brushless motor 57 of the 3rd example is used, using a brushless motor as a motor 7 of the former ( drawing 10 ), since he is trying to make it change only with PWM control, the iron loss by the iron contained in the permanent magnet of Rota by the harmonic content contained in applied voltage will become size, and the problem Rota carries out [ a problem ] a temperature rise remarkably will produce the applied voltage to a motor 7.
[0087] on the other hand, when according to this 3rd example a chopper circuit 26 acts as a chopper for pressure ups in order to rotate a brushless motor 57 above the engine speed at the time of a stationary Since a control circuit 42 is controlled to make transistor 16U of an inverter circuit 15 thru/or 16W or 17U thru/or 17W into the PWM duty 100 (%) The iron loss of Rota by the harmonic content of the applied voltage based on PWM control becomes remarkably small, and can prevent generation of heat of Rota as much as possible. And since it can be made higher than the conventional PWM duty even when rotating a brushless motor 57 under at the engine speed at the time of a stationary, iron loss by the harmonic content of Rota can be made small.
[0088] Drawing 9 shows the Rota temperature characteristic acquired by experiment of this invention persons. In addition, both the electrical potential differences of dc-batteries 1 and 13 are 330V. <A HREF="/Tokujitu/tjitemdrw.ipdl?N0000=239&N0500=1E_N/;?7=>;:6=///&N0001=934&N0552=9&N0553=000011" -- the temperature characteristic A plotted by ** in TARGET="tjitemdrw"> drawing 9 is the Rota temperature characteristic of the motor 7 at the time of driving a motor 7 with the driving gear of the conventional motor, and making it run an electric vehicle by 80 km/h. Rating of a motor 7 is 330 (V), and 10000 (rpm) and 10 (N-m), the main circuit electrical potential difference of the driving gear of the motor at the time of a drive is 330 (V), and PWM duty is 30 (%). In addition, the axis of abscissa of drawing 9 is time amount (minute), and an axis of ordinate is temperature (deg).
[0089] Moreover, the temperature characteristic B plotted by x in drawing 9 is the Rota temperature characteristic of the brushless motor 57 at the time of driving a brushless motor 57 with motorised equipment 14 as shown in drawing 8 , and making it run an electric vehicle by 80 km/h. Rating of a brushless motor 57 is 660 (V), and 10000 (rpm) and 10 (N-m), the main circuit electrical potential difference of the motorised equipment 14 at the time of a drive is 330 (V), and PWM duty is 60 (%).
[0090] The temperature characteristic B shows the property that the temperature rise over time amount progress is low, and good, as

compared with the temperature characteristic A so that clearly from drawing 9 . This is because can use the brushless motor 57 of the rated voltage 660 higher than the electrical potential difference of a dc-battery 13 (V) since motorised equipment 14 makes a chopper circuit 26 act as a chopper for pressure ups and can carry out the pressure up of the main circuit electrical potential difference of an inverter circuit 15, the same rate as the former is obtained by this, so PWM duty can be made high.
[0091] Namely, what is necessary is just to double PWM duty, in order to obtain the same rotational speed as the former by the brushless motor 57 whose rated voltage is twice the brushless motor 7, when the electrical potential difference of dc-batteries 1 and 13 is the same. Therefore, the harmonic content by which only the part to which PWM duty became large is contained in an PWM signal will decrease, and generation of heat which arises with iron loss in the permanent magnet of Rota of a brushless motor 57 will decrease in connection with it.
[0092] According to the problem of the temperature rise by this iron loss, when driving a motor with the conventional driving gear, the permanent magnet which consists of a ferrite etc. had to be used for Rota of that motor, but as mentioned above, according to the 3rd example, even if it uses for Rota of a brushless motor 57 the permanent magnet which consists of Nd-Fe-B containing iron, generation of heat by the iron loss of that permanent magnet can be controlled. Therefore, from before, it can become possible to use the high magnetic material of coercive force, and the effectiveness of a brushless motor 57 can be raised, and suppose that it is long lasting at the permanent magnet of Rota. In addition, although Nd-Fe-B was used as the magnetic substance of a permanent magnet in the above-mentioned example, if it is the magnetic substance containing iron, it is good anything, without restricting to this.
[0093] Moreover, although the induction motor 11 or the brushless motor 57 was used as a motor in the above-mentioned example Instead, 2 phase motor, a direct-current motor with a brush, or a reluctance motor may be used. In this case There are some (for example, direct-current motor with a brush) which have only one arm which comes to connect with a two-piece serial the switching element slack transistor which has a fly wheel diode as a drive circuit, therefore it has one or more arms with an object as a drive circuit.
[0094] Furthermore, although the triac 48 was formed as a switching element for current limiting, you may make it prepare two photo thyristors or photograph triac which could prepare instead two thyristors which carried out antiparallel connection, or carried out antiparallel connection in the above-mentioned example.
[0095] In addition, as for the ability to carry out by deforming suitably within limits which do not deviate from a summary, it is needless to say that this invention is applicable to the equipment at large which needs the motorised equipment which is not limited only to the above-mentioned example and drives a motor by using not only an electric vehicle but a dc-battery as a power source etc.
[0096]
[Effect of the Invention] Since this invention is as having explained above, it does the following effectiveness so. Since according to the driving gear of a motor claim 1 and given in two it can act by making a chopper circuit into the chopper for pressure ups when supplying power to a motor through a drive circuit from a dc-battery, it can become possible to impress an electrical potential difference higher than battery voltage to a motor, a motor can be made to drive at a rotational frequency higher than the time of a stationary, and the effectiveness at the time of steady operation can be improved. Moreover, since it can act by making a chopper circuit into the chopper for pressure lowering when supplying power to a dc-battery from a drive circuit, a dc-battery can be charged smoothly, without the motor generation-of-electrical-energy electrical potential difference or the external power electrical potential difference having also been higher than battery voltage, and damaging a circuit element, when carrying out regenerative braking of the motor, or when charging a dc-battery from an external power.
[0097] According to the driving gear of a motor according to claim 3, at the time of regenerative braking of a motor, when a motor generation-of-electrical-energy electrical potential difference is lower than battery voltage, the arm comes to act as a chopper for pressure ups by carrying out on-off control of the negative side switching element of the arm of a drive circuit.
[0098] One arm acts as a chopper for pressure ups, and the pressure up of the full-wave-rectification electrical potential difference comes to be carried out, therefore it is not necessary to form the battery charger of dedication for charge of a dc-battery and, and according to the driving gear of a motor according to claim 4, at the time of charge of a dc-battery, while full wave rectification of the external AC power supply is carried out by the full wave rectifier circuit, even when an AC-power-supply electrical potential difference is lower than battery voltage, charge of a dc-battery is attained.
[0099] According to the driving gear of a motor according to claim 5, since a control means controls the energization phase of the thyristor of a full wave rectifier circuit based on the detection current of an ac side current detection means to become size from abbreviation 0 gradually, it can control the rush current at the time of charge initiation.
[0100] According to the driving gear of a motor according to claim 6, a control means can control the charging current to a predetermined value, and can make the stable charge perform at the time of charge of a dc-battery, since the on-off duty of the chopper circuit which acts as a chopper for pressure lowering based on the detection current of a direct-current side current detection means is raised gradually.
[0101] According to the driving gear of a motor according to claim 7, at the time of charge of a dc-battery, since a control means adjusts the on-off duty of the chopper for pressure ups and controls the charging current when the detection current of a direct-current side current detection means does not reach a predetermined value, it does so the same effectiveness as claim 6.
[0102] According to the driving gear of a motor according to claim 8, even if it prepares a switching circuit and a bidirectional 3 terminal thyristor, the same operation effectiveness as claim 5 is acquired. Since power factor improvement can be aimed at since the current which flows from external AC power supply to a reference signal is made to follow according to the driving gear of a motor given in claims 9 and 10, and a capacitor is charged at the electrical potential difference beyond the peak value of an AC-power-supply electrical potential difference, it is controllable so that the charging current of a dc-battery becomes fixed according to an operation with the chopper for pressure lowering.
[0103] According to the driving gear of a motor according to claim 11, since a chopper circuit is made to act as a chopper for pressure lowering also when the electrical potential difference between terminals of a capacitor is higher than the charge electrical potential difference of a dc-battery, the same effectiveness as claim 10 is acquired.
[0104] According to the driving gear of a motor according to claim 12, since the PWM duty of a drive circuit is impressed to a motor in the condition that the reference voltage of a dc-battery changes with 100% in the output for which a motor is used most frequently, it can design a motor and a drive circuit according to a stationary output.
[0105] According to the driving gear of a motor according to claim 13, since AC power supply is made to revive the residual energy at the time of refresh actuation of a dc-battery, energy efficiency becomes good and the resistor for discharge becomes unnecessary. According to the driving gear of a motor according to claim 14, since the chopper circuit was constituted from a transistor module, a configuration becomes easy.
[0106] Since Rota constituted with the permanent magnet which comes to contain iron in a motor was used according to the driving gear of a motor according to claim 15, the temperature rise of Rota can be prevented as much as possible, being able to raise the

effectiveness of a motor and being long lasting.

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[Translation done.]

* NOTICES *



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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]
[Drawing 1] The electric block diagram showing the 1st example of this invention
[Drawing 2] The property Fig. of a motor (the 1)
[Drawing 3] The property Fig. of a motor (the 2)
[Drawing 4] The wave form chart of each part at the time of charge of a dc-battery (the 1)
[Drawing 5] The wave form chart of each part at the time of charge of a dc-battery (the 2)
[Drawing 6] The drawing 1 equivalent Fig. showing the 2nd example of this invention
[Drawing 7] The block diagram of a contactor
[Drawing 8] The drawing 1 equivalent Fig. showing the 3rd example of this invention
[Drawing 9] Drawing showing the temperature characteristic of Rota
[Drawing 10] The electric block diagram showing the conventional example
[Description of Notations]
An induction motor (motor) and 13 among a drawing 11 A dc-battery, An inverter circuit (drive circuit), 16U or 16W and 17U thru/or 17W 15 A transistor (switching element), 18U 18W and 19U thru/or 19W A fly wheel diode, 20U thru/or 20W a capacitor and 26 for an arm and 22 A chopper circuit, 32 a full wave rectifier circuit, and 33a and 33b for a direct-current side reactor and 33 A thyristor, 34 a direct-current-voltage detector and 39 for an ac side reactor and 38 An alternating current detector (ac side current detection means), 40 -- in a charging current detector (direct-current side current detection means) and 41, a switching circuit and 48 show a bidirectional triode thyristor, and, as for a zero crossing point sensor and 42, 57 shows a brushless motor (motor), as for a control circuit (control means) and 43.

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[Translation done.]

* NOTICES *



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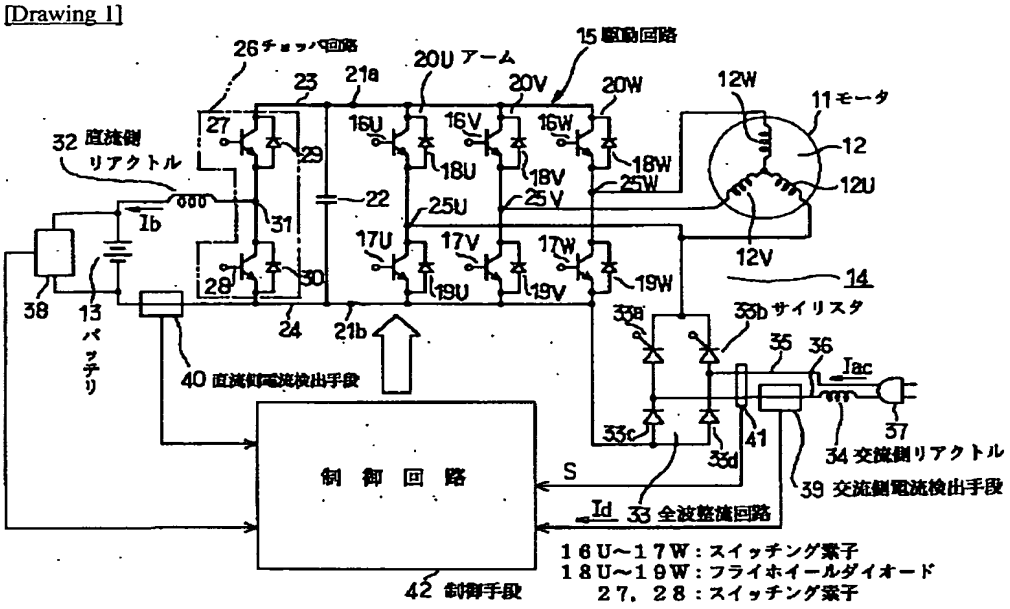
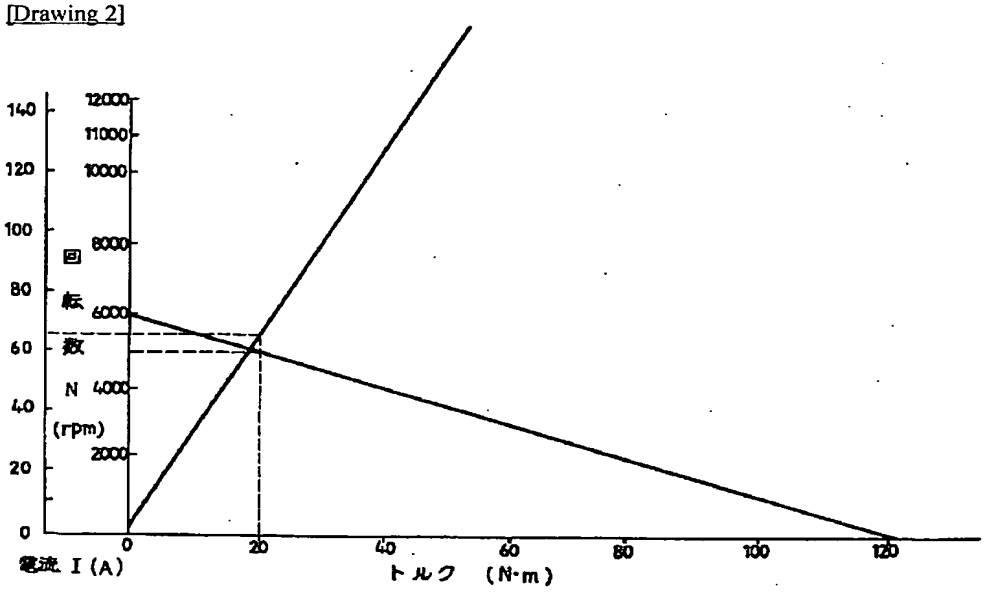
DRAWINGS

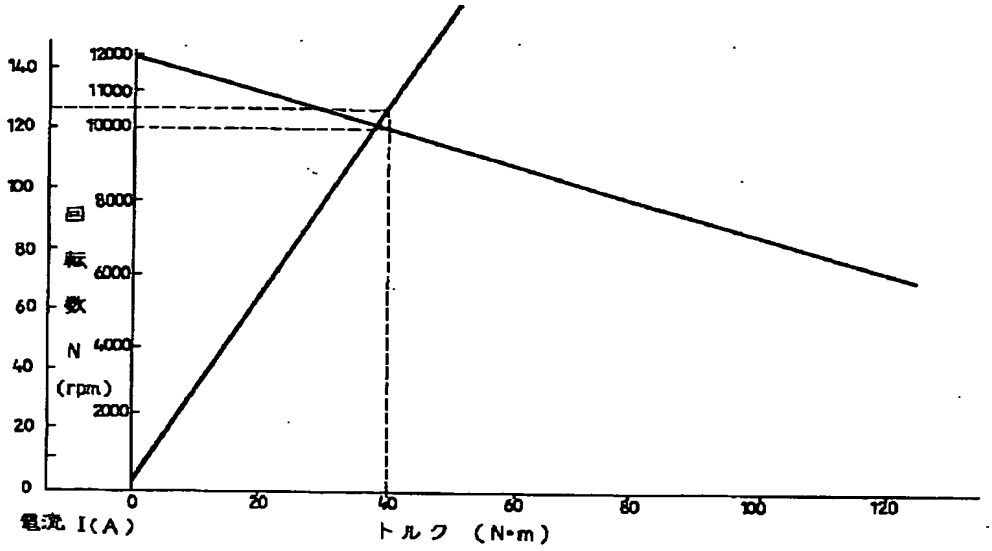
[Drawing 1]



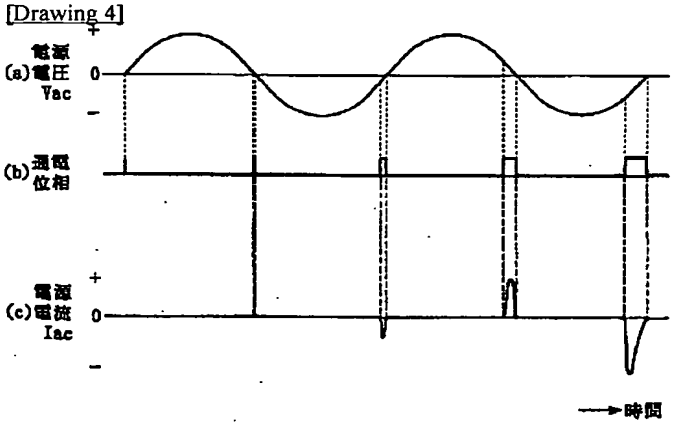

[Drawing 2]



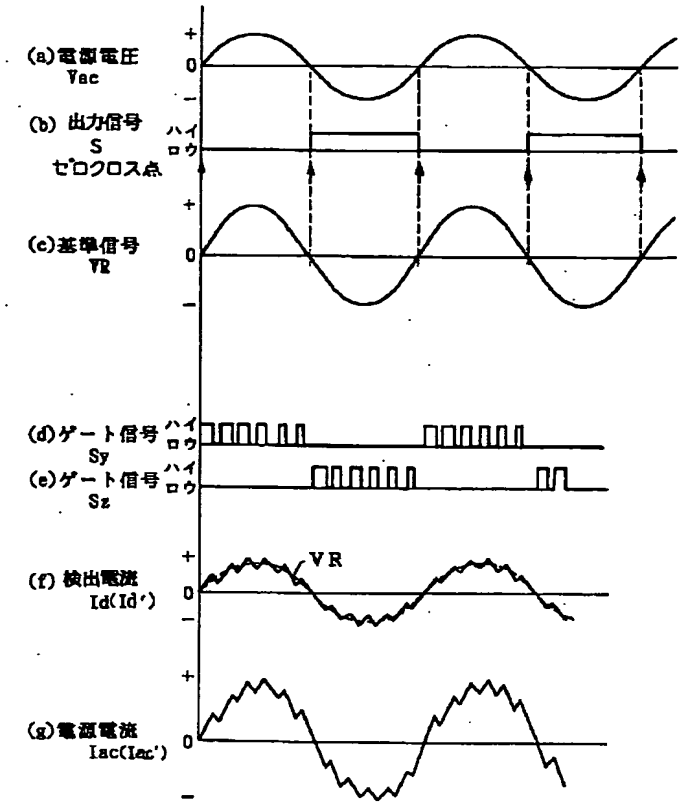

[Drawing 3]



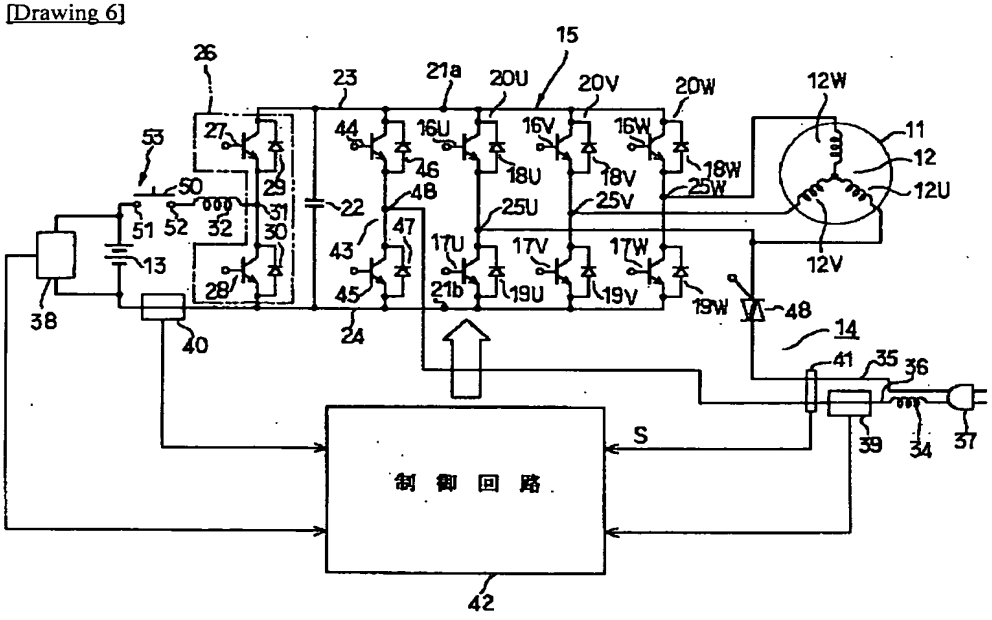

[Drawing 4]



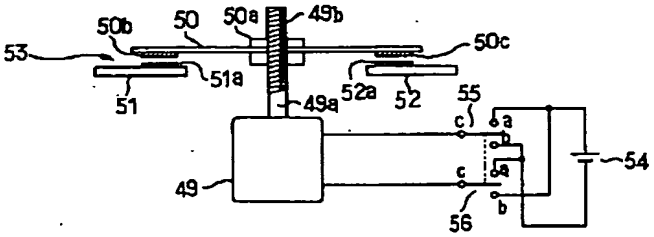

[Drawing 5]



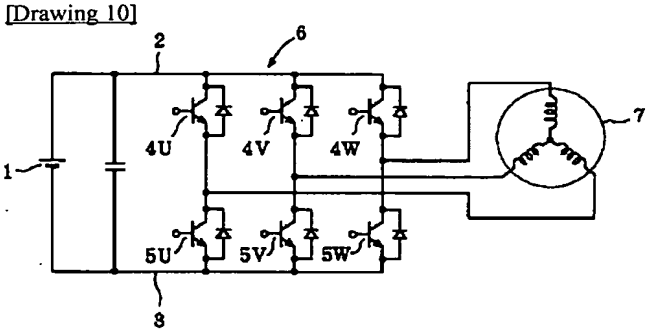

[Drawing 6]



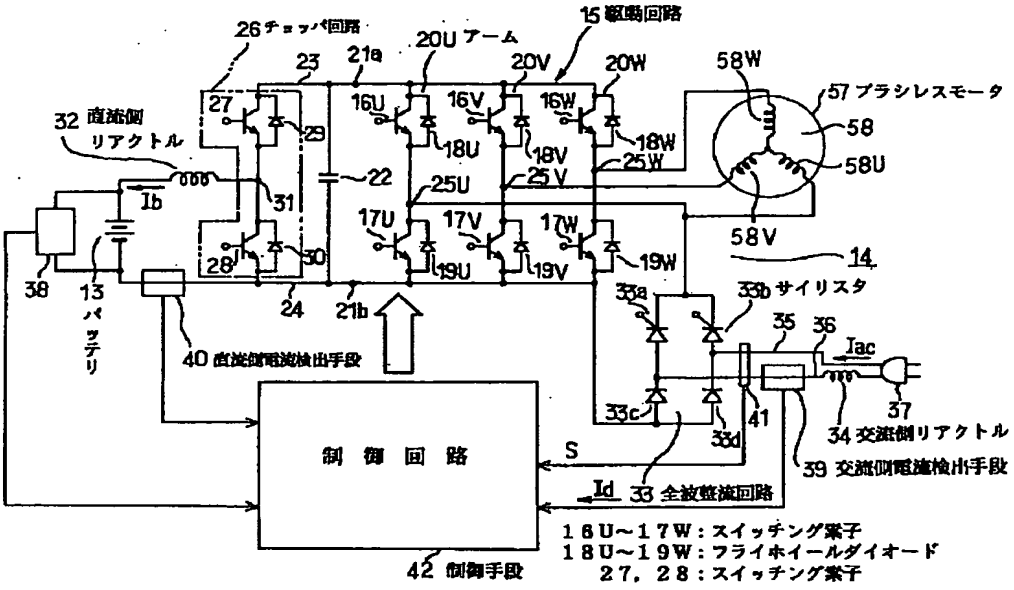

[Drawing 7]



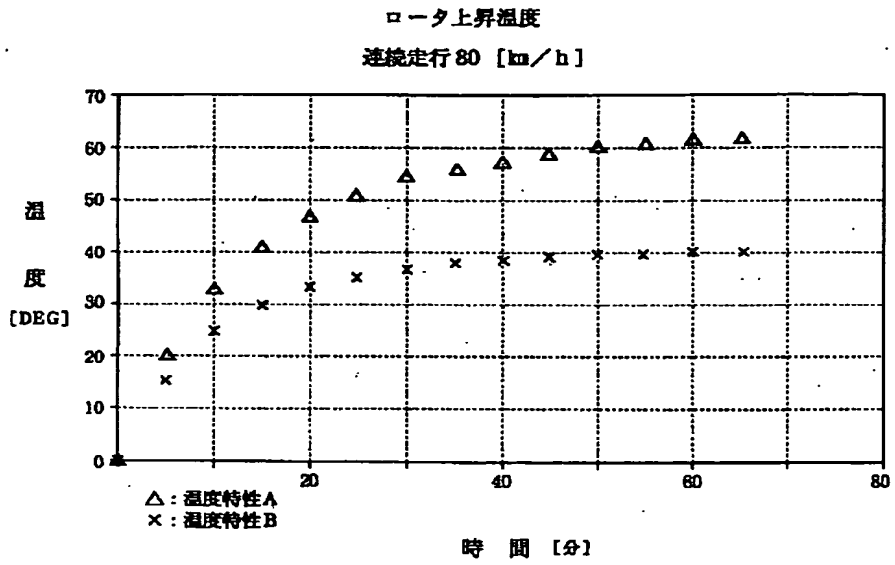

[Drawing 10]




[Drawing 8]




[Drawing 9]




[Translation done.]

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CORRECTION OR AMENDMENT

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[Kind of official gazette] Printing of amendment by the convention of 2 of Article 17 of Patent Law
[Section partition] The 4th partition of the 7th section
[Publication date] March 29, Heisei 14 (2002. 3.29)

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H02M 3/155
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[FI]

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9/18 J
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H02J 7/00 J
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7/538 A
7/797

[Procedure revision]
[Filing Date] October 16, Heisei 13 (2001. 10.16)
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] Claim
[Method of Amendment] Modification
[Proposed Amendment]
[Claim(s)]
[Claim 1] The drive circuit which it has one or more arms which come to connect with a serial two switching elements which have a fly wheel diode, an input terminal is connected to a dc-battery, and an output terminal is connected to a motor, and carries out energization control of said motor by turning on and off of said switching element,
The chopper circuit which comes to connect with a serial two switching elements which are connected to juxtaposition in this drive circuit, and have a fly wheel diode,
The direct-current side reactor connected between the neutral point of this chopper circuit, and a dc-battery,
The driving gear of the motor which comes to provide the control means whose operation is established so that on-off control of the switching element of said drive circuit and a chopper circuit may be carried out, enables the operation of said chopper circuit as a chopper for pressure ups when supplying power to a drive circuit from said dc-battery, and is enabled as a chopper for pressure lowering when supplying power to a dc-battery from said drive circuit.
[Claim 2] A control means is the driving gear of the motor according to claim 1 characterized by controlling to supply the reference voltage of a dc-battery to a drive circuit when a motor output is low, and to make a chopper circuit act as a chopper for pressure ups when a motor output is high.
[Claim 3] A control means is the driving gear of the motor according to claim 1 characterized by being constituted so that a chopper circuit may be made to act as a chopper for pressure lowering at the time of the regeneration of a motor when a motor generation-of-electrical-energy electrical potential difference is higher than battery voltage, the charging current to a dc-battery may be controlled, it may be made to act as a chopper for pressure ups by carrying out on-off control of the negative side switching element of the arm of a drive circuit when a motor generation-of-electrical-energy electrical potential difference is lower than battery voltage and the charging current to a dc-battery may be controlled.
[Claim 4] While having a full wave rectifier circuit for carrying out full wave rectification of the external AC power supply and connecting the ac side reactor to the alternating current input terminal side A forward side direct-current output terminal attains to the neutral point of one arm of a drive circuit, and a negative side direct-current output terminal is connected to the negative terminal of a

dc-battery. A control means The driving gear of the motor according to claim 1 characterized by being constituted so that it may be made to act as a chopper for pressure ups by carrying out on-off control of the negative side switching element of said one arm at the time of charge of the dc-battery by external AC power supply.
[Claim 5] It is the driving gear of the motor according to claim 4 characterized by having an ac side current detection means to detect the charging current which flows in a drive circuit through a full wave rectifier circuit from AC power supply, constituting the full wave rectifier circuit including two or more thyristors, and constituting the control means so that the energization phase of said thyristor may be controlled based on the detection current of said ac side current detection means to become size from abbreviation 0 gradually.
[Claim 6] It is the driving gear of the motor according to claim 4 characterized by having a direct-current side current detection means to detect the charging current which flows to a dc-battery, and constituting the control means so that the on-off duty of the chopper for pressure lowering may be gradually raised based on the detection current of the direct-current side current detection means and the charging current may be controlled to a predetermined value.
[Claim 7] A control means is the driving gear of the motor according to claim 6 characterized by being constituted so that the on-off duty of the chopper for pressure ups may be adjusted and the charging current may be controlled, when the detection current of a direct-current side current detection means does not reach a predetermined value.
[Claim 8] The driving gear of the motor according to claim 5 characterized by connecting the switching circuit which comes to connect with a serial two switching elements which have a fly wheel diode in a drive circuit at juxtaposition, and using the bidirectional triode thyristor instead of being a full wave rectifier circuit.
[Claim 9] A control means is the driving gear of the motor according to claim 4 characterized by being constituted so that it may control to make the alternating current which flows from external AC power supply follow the reference signal of the sine wave which synchronized with the AC-power-supply electrical potential difference.
[Claim 10] It is the driving gear of the motor according to claim 9 which a capacitor is connected to juxtaposition in a drive circuit, and is characterized by constituting the control means so that the electrical potential difference between terminals of a capacitor becomes beyond the peak value of an external AC-power-supply electrical potential difference and it may control.
[Claim 11] A control means is the driving gear of the motor according to claim 9 or 10 characterized by being constituted so that a chopper circuit may be made to act as a chopper for pressure lowering and current limiting may be performed, when the electrical potential difference between terminals of a capacitor is higher than the charge electrical potential difference of a dc-battery.
[Claim 12] The driving gear of the motor according to claim 2 by which reference voltage of a dc-battery is characterized by being constituted so that it may be impressed by the motor in the condition that the PWM duty of a drive circuit becomes 100% in the output for which a motor is used most frequently.
[Claim 13] A control means is the driving gear of the motor according to claim 8 characterized by being constituted so that external AC power supply may be made to revive the residual energy of the dc-battery at the time of refresh actuation of a dc-battery by carrying out on-off control of one arm of a drive circuit, and the switching element of a switching circuit.
[Claim 14] A chopper circuit is the driving gear of the motor according to claim 1 to 13 characterized by consisting of transistor modules which consist of two transistors which have a fly wheel diode in juxtaposition.
[Claim 15] A motor is the driving gear of the motor according to claim 1 to 14 characterized by using Rota constituted with the permanent magnet which comes to contain iron.
[Claim 16] The inverter circuit which has one or more arms which come to connect two switching elements with a serial,
The chopper circuit which is connected to juxtaposition at this inverter circuit, and comes to connect two switching elements with a serial,
The dc-battery by which a positive terminal is connected through a reactor at the neutral point of this chopper circuit, and a negative terminal is connected to the direct-current bus-bar of a negative side,
The direct-current-voltage detector which detects the electrical potential difference between terminals of this dc-battery,
The motor constituted so that said Rota may rotate by having a stator coil and Rota and the power from said dc-battery being supplied through said inverter circuit,
When the generation-of-electrical-energy electrical potential difference at the time of the regeneration of said motor is higher than the electrical potential difference between terminals of said dc-battery, said chopper circuit is made to act as a chopper for pressure lowering. When the generation-of-electrical-energy electrical potential difference of said motor is lower than the electrical potential difference between terminals of said dc-battery The driving gear of the motor which comes to provide the control means which controls the charging current to said dc-battery by making the chopper circuit concerned act as a chopper for pressure ups by repeating turning on and off of the direction arranged at the inner negative side of the switching element which constitutes said chopper circuit.
[Claim 17] The motor which has Rota and the stator of two or more layers,
It has a dc-battery used as the power source of this motor,
Said drive circuit is the driving gear of a motor given in claim 1 thru/or any of 15 they are. [ which is characterized by performing energization control on said motor with the power outputted from said dc-battery ]
[Claim 18] Said motor is the driving gear of the motor according to claim 17 characterized by being the drive motor of an electric vehicle.

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[Translation done.]

# EUROPEAN PATENT OFFICE

## Patent Abstracts of Japan


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APPLICATION NUMBER : 07076418



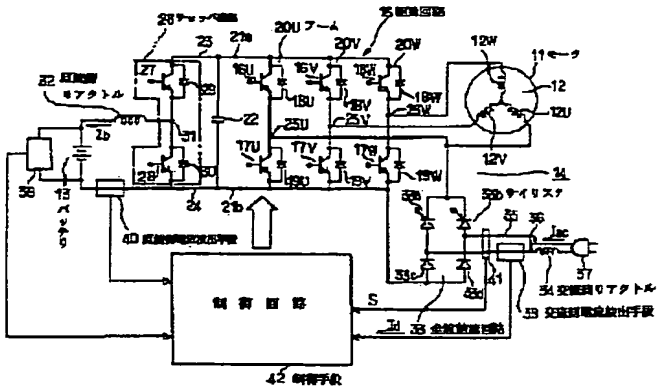
APPLICANT : TOSHIBA CORP;

INVENTOR : KATO SEIJI;



INT.CL. : H02P 7/63 B60L 7/14 B60L 9/18 B60L 11/18 H02J 7/00 H02M 3/155 H02M 7/538 H02M 7/797


TITLE : MOTOR DRIVING APPARATUS




ABSTRACT : PURPOSE: To facilitate the driving and regenerative braking of a motor, the charge of a battery and the refreshment of the battery with a simple construction.

CONSTITUTION: A chopper circuit 26 is provided in parallel with an inverter circuit 15. When the power of an induction motor 11 is high, the chopper circuit 26 is made to function as a step-up chopper. When the induction motor 11 is in a regenerative operation, the chopper circuit 26 is made to function as a step-down chopper.

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| | 9/18 | Ｊ | | | |
| | 11/18 | Ｅ | | | |
| Ｈ０２Ｊ | 7/00 | Ｊ | | | |

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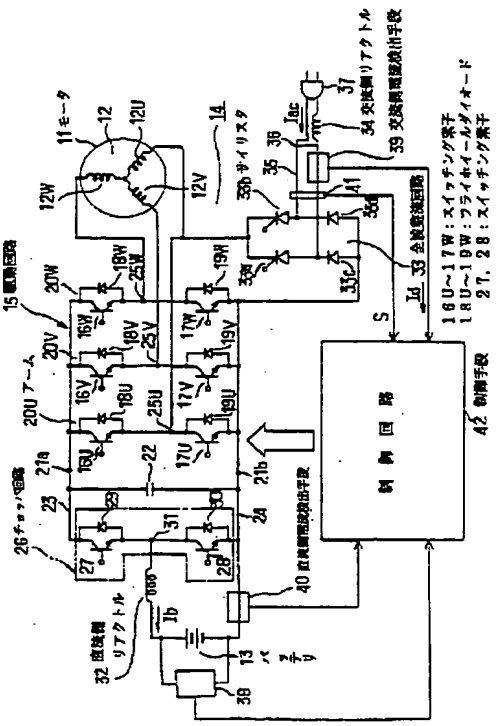
最終頁に続く

(54)【発明の名称】　モータの駆動装置

(57)【要約】

【目的】　モータの駆動，回生制動及びバッテリの充電を簡単な構成で実現することができ、そして、バッテリのリフレッシュをも行なわせることができるようにする。

【構成】　インバータ回路１５に並列にチョッパ回路２６を設け、インダクションモータ１１の高出力時には、チョッパ回路２６を昇圧用チョッパとして作用させ、又、インダクションモータ１１の回生時には、チョッパ回路２６を降圧用チョッパとして作用させる。



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【特許請求の範囲】

【請求項１】　フライホイールダイオードを有する２個のスイッチング素子を直列に接続してなるアームを１つ以上有し、入力端子がバッテリに接続され、出力端子がモータに接続されて、前記スイッチング素子のオンオフにより前記モータを通電制御する駆動回路と、

この駆動回路に並列に接続されフライホイールダイオードを有する２個のスイッチング素子を直列に接続してなるチョッパ回路と、

このチョッパ回路の中性点とバッテリとの間に接続された直流側リアクトルと、　前記駆動回路及びチョッパ回路のスイッチング素子をオンオフ制御するように設けられ、前記チョッパ回路を、前記バッテリから駆動回路に電力を供給するときには昇圧用チョッパとして作用可能とし、前記駆動回路からバッテリに電力を供給するときには降圧用チョッパとして作用可能とする制御手段とを具備してなるモータの駆動装置。

【請求項２】　制御手段は、モータ出力が低いときには駆動回路にバッテリの基準電圧を供給し、モータ出力が高いときにはチョッパ回路を昇圧用チョッパとして作用させるように制御することを特徴とする請求項１記載のモータの駆動装置。

【請求項３】　制御手段は、モータの回生時において、モータ発電電圧がバッテリ電圧より高い場合にはチョッパ回路を降圧用チョッパとして作用させてバッテリへの充電電流を制御し、モータ発電電圧がバッテリ電圧より低い場合には駆動回路のアームの負側スイッチング素子をオンオフ制御することにより昇圧用チョッパとして作用させてバッテリへの充電電流を制御するように構成されていることを特徴とする請求項１記載のモータの駆動装置。

【請求項４】　外部の交流電源を全波整流するための全波整流回路を備えて、その交流入力端子側に交流側リアクトルが接続されているとともに、正側直流出力端子が駆動回路の１つのアームの中性点に及び負側直流出力端子がバッテリの負端子に接続され、制御手段は、外部の交流電源によるバッテリの充電時には、前記１つのアームの負側スイッチング素子をオンオフ制御することにより昇圧用チョッパとして作用させるように構成されていることを特徴とする請求項１記載のモータの駆動装置。

【請求項５】　交流電源から全波整流回路を介して駆動回路に流れる充電電流を検出する交流側電流検出手段を備え、その全波整流回路は２個以上のサイリスタを含んで構成され、制御手段は、前記交流側電流検出手段の検出電流に基づいて前記サイリスタの通電位相を略零から徐々に大となるように制御するように構成されていることを特徴とする請求項４記載のモータの駆動装置。

【請求項６】　バッテリに流れる充電電流を検出する直流側電流検出手段を備え、制御手段は、その直流側電流検出手段の検出電流に基づいて降圧用チョッパのオンオフデューティを徐々に上昇させてその充電電流を所定値に制御するように構成されていることを特徴とする請求項４記載のモータの駆動装置。

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【請求項７】　制御手段は、直流側電流検出手段の検出電流が所定値に達しない場合には、昇圧用チョッパのオンオフデューティを調整して充電電流を制御するように構成されていることを特徴とする請求項６記載のモータの駆動装置。

【請求項８】　駆動回路に並列にフライホイールダイオードを有する２個のスイッチング素子を直列に接続してなるスイッチング回路が接続され、全波整流回路の代わりに双方向性三端子サイリスタが用いられていることを特徴とする請求項５記載のモータの駆動装置。

【請求項９】　制御手段は、外部の交流電源から流れる交流電流を交流電源電圧に同期した正弦波の基準信号に追従させるように制御するように構成されていることを特徴とする請求項４記載のモータの駆動装置。

【請求項１０】　駆動回路に並列にコンデンサが接続され、制御手段は、コンデンサの端子間電圧が外部の交流電源電圧のピーク値以上となるように制御するように構成されていることを特徴とする請求項９記載のモータの駆動装置。

【請求項１１】　制御手段は、コンデンサの端子間電圧がバッテリの充電電圧よりも高い場合には、チョッパ回路を降圧用チョッパとして作用させて電流制限を行なうように構成されていることを特徴とする請求項９又は１０記載のモータの駆動装置。

【請求項１２】　モータの最も頻繁に使用される出力において、バッテリの基準電圧が駆動回路のＰＷＭデューティが１００％なる状態でモータに印加されるように構成されていることを特徴とする請求項２記載のモータの駆動装置。

【請求項１３】　制御手段は、駆動回路の１つのアーム及びスイッチング回路のスイッチング素子をオンオフ制御することによって、バッテリのリフレッシュ動作時にそのバッテリの残存エネルギーを外部の交流電源に回生させるように構成されていることを特徴とする請求項８記載のモータの駆動装置。

【請求項１４】　チョッパ回路は、フライホイールダイオードを並列に有する２個のトランジスタからなるトランジスタモジュールにて構成されていることを特徴とする請求項１乃至１３のいずれかに記載のモータの駆動装置。

【請求項１５】　モータは、鉄を含んでなる永久磁石によって構成されたロータを用いることを特徴とする請求項１乃至１４のいずれかに記載のモータの駆動装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、バッテリの直流電力を駆動回路により交流電力に変換してモータに供給するよ

うにしたモータの駆動装置に関する。

【０００２】

【従来の技術】例えば、電気自動車のモータを駆動する駆動装置の従来例を図１０に示す。即ち、ニッケル系電池（ニッケル水素電池，ニッケルカドミ電池）からなるバッテリ１の正及び負端子には、直流母線２及び３が接続されているとともに、この直流母線２及び３間には、６個のトランジスタ４Ｕ乃至４Ｗ及び５Ｕ乃至５Ｗをブリッジ接続してなるインバータ回路６が接続され、そのインバータ回路６の出力端子はモータ７の入力端子に接続されている。この場合、バッテリ１の直流電圧は、直接、インバータ回路６に印加されるので、モータ７の出力（回転数）制御は、インバータ回路６をＰＷＭ制御することにより実行される。

【０００３】又、バッテリ１が放電して電圧が降下すると、モータ７を駆動するのに必要な電力が得られなくなるので、従来より、電気自動車には、バッテリを充電するために、外部の交流電源の交流電源電圧を変圧するトランス及びこのトランスからの交流電圧を整流して平滑して直流電圧とする整流平滑回路等から構成された充電器が搭載されている。

【０００４】更に、ニッケル系電池からなるバッテリ１は、メモリ効果によりバッテリ１内部の充電電力を１００％放出できなくなるので、従来より、バッテリ１の残存電力をその電圧が下限電圧になるまで放電用抵抗器に放電させるリフレッシュ動作を行なわせるようになっている。

【０００５】

【発明が解決しようとする課題】上記従来の構成では、次のような解決すべき課題があった。

（ａ）電気自動車においては、走行上、モータ７に必要とされる最大出力が大きいのであるが、定常出力は小さく、当然のことながら、最大出力に応じてモータ７及びインバータ回路６の容量が設定される。この場合、モータ７の低出力時にインバータ回路６のＰＷＭ制御により回転数を低くするためには、モータ７に対する印加電圧を低くすべくＰＷＭのパルス幅を非常に小にする必要があり、従って、モータ７の印加電圧には高調波成分が多く含まれることになり、この高調波成分によりモータ７に主として鉄損からなるモータ損失が発生して、定常運転時の効率が悪くなる。

【０００６】（ｂ）モータ７が高出力から低出力に変化するときには、モータ７からバッテリ１に対して回生電力が供給されるが、このときのモータ７の回転数によりモータ発電電圧がバッテリ電圧に対して大小異なるので、適正な回生制動が行なわれない。

【０００７】（ｃ）バッテリ１の充電のためにトランス等を有する充電器が必要であるので、製造コストが増加し、特に、トランスを含む充電器は広い設置スペースを必要とするので、電気自動車にとっては不利である。



【０００８】（ｄ）バッテリ１をリフレッシュするために残存電力を放電用抵抗器でジュール熱として放散させるので、エネルギー効率が悪く、又、大形の放電用抵抗器を設ける必要があり、特に、大形の放電用抵抗器は広い設置スペースを必要とするので、電気自動車にとっては不利である。

【０００９】本発明は上記事情に鑑みてなされたもので、その第１の目的は、モータの定常運転時の効率をよくすることができるモータの駆動装置を提供するにある。

【００１０】本発明の第２の目的は、モータの回生制動時において、モータ発電電圧の大小にかかわらず円滑な回生制動を行なうことができるモータの駆動装置を提供するにある。

【００１１】本発明の第３の目的は、バッテリの充電のために専用の充電器を必要としないモータの駆動装置を提供するにある。

【００１２】本発明の第４の目的は、バッテリのリフレッシュ時に放電用抵抗器を必要としないモータの駆動装置を提供するにある。

【００１３】

【課題を解決するための手段】請求項１記載のモータの駆動装置は、フライホイールダイオードを有する２個のスイッチング素子を直列に接続してなるアームを１つ以上有し、入力端子がバッテリに接続され、出力端子がモータに接続されて、前記スイッチング素子のオンオフにより前記モータを通電制御する駆動回路と、この駆動回路に並列に接続されフライホイールダイオードを有する２個のスイッチング素子を直列に接続してなるチョッパ回路と、このチョッパ回路の中性点とバッテリとの間に接続された直流側リアクトルと、前記駆動回路及びチョッパ回路のスイッチング素子をオンオフ制御するように設けられ、前記チョッパ回路を、前記バッテリから駆動回路に電力を供給するときには昇圧用チョッパとして作用可能とし、前記駆動回路からバッテリへの電力を供給するときには降圧用チョッパとして作用可能とする制御手段とを具備してなる構成に特徴を有する。

【００１４】請求項２記載のモータの駆動装置は、制御手段を、モータ出力が低いときには駆動回路にバッテリの基準電圧を供給し、モータ出力が高いときにはチョッパ回路を昇圧用チョッパとして作用させるように制御する構成とするところに特徴を有する。

【００１５】請求項３記載のモータの駆動装置は、制御手段を、モータの回生時において、モータ発電電圧がバッテリ電圧より高い場合にはチョッパ回路を降圧用チョッパとして作用させてバッテリへの充電電流を制御し、モータ発電電圧がバッテリ電圧より低い場合には駆動回路のアームの負側スイッチング素子をオンオフ制御することにより昇圧用チョッパとして作用させてバッテリへの充電電流を制御するように構成するところに特徴を有

する。

【００１６】請求項４記載のモータの駆動装置は、外部の交流電源を全波整流するための全波整流回路を備えて、その交流入力端子側に交流側リアクトルを接続するとともに、正側直流出力端子を駆動回路の１つのアームの中性点に接続し、及び負側直流出力端子をバッテリの負端子に接続し、制御手段を、外部の交流電源によるバッテリの充電時には、前記１つのアームの負側スイッチング素子をオンオフ制御することにより昇圧用チョッパとして作用させるように構成するところに特徴を有する。

【００１７】請求項５記載のモータの駆動装置は、交流電源から全波整流回路を介して駆動回路に流れる充電電流を検出する交流側電流検出手段を備え、その全波整流回路を２個以上のサイリスタを含んで構成し、制御手段を、前記交流側電流検出手段の検出電流に基づいて前記サイリスタの通電位相を略零から徐々に大となるように制御するように構成するところに特徴を有する。

【００１８】請求項６記載のモータの駆動装置は、バッテリに流れる充電電流を検出する直流側電流検出手段を備え、制御手段を、その直流側電流検出手段の検出電流に基づいて降圧用チョッパとして作用するチョッパ回路のオンデューティを徐々に上昇させることによってその充電電流を所定値に制御するように構成するところに特徴を有する。

【００１９】請求項７記載のモータの駆動装置は、制御手段を、直流側電流検出手段の検出電流が所定値に達しない場合には、昇圧チョッパのオンオフデューティを調整して充電電流を制御する構成とするところに特徴を有する。

【００２０】請求項８記載のモータの駆動装置は、駆動回路に並列にフライホイールダイオードを有する２個のスイッチング素子を直列に接続してなるスイッチング回路を接続し、全波整流回路の代わりに双方向性三端子サイリスタが用いる構成に特徴を有する。

【００２１】請求項９及び１０記載のモータの駆動装置は、駆動回路に並列にコンデンサを接続し、制御手段を、外部の交流電源から流れる交流電流を交流電源電圧に同期した正弦波の基準信号に追従させるように制御することにより、前記コンデンサの端子間電圧が交流電源電圧のピーク値以上となるようにして力率制御を行なうように構成するところに特徴を有する。

【００２２】請求項１１記載のモータの駆動装置は、制御手段を、コンデンサの端子間電圧がバッテリの充電電圧よりも高い場合には、チョッパ回路を降圧用チョッパとして作用させて電流制限を行なうように構成するところに特徴を有する。

【００２３】請求項１２記載のモータの駆動装置は、モータの最も頻繁に使用される出力において、バッテリの基準電圧が駆動回路のＰＷＭデューティが１００％なる



状態でモータに印加されるように構成したところに特徴を有する。

【００２４】請求項１３記載のモータの駆動装置は、制御手段を、駆動回路の１つのアーム及びスイッチング回路のスイッチング素子をオンオフ制御することによって、バッテリのリフレッシュ動作時にそのバッテリの残存エネルギーを外部の交流電源に回生させるように構成するところに特徴を有する。

【００２５】請求項１４記載のモータの駆動装置は、チョッパ回路を、フライホイールダイオードを並列に有する２個のトランジスタからなるトランジスタモジュールにて構成するところに特徴を有する。

【００２６】請求項１５記載のモータの駆動装置は、モータに、鉄を含んでなる永久磁石によって構成されたロータを用いることに特徴を有する。

【００２７】

【作用】請求項１及び２記載のモータの駆動装置によれば、バッテリから駆動回路を介してモータに電力を供給するときには、チョッパ回路を昇圧用チョッパとして作用可能であるので、バッテリ電圧よりも高い電圧をモータに印加することが可能になって、モータを定常時よりも高い回転数で駆動させることができる。又、駆動回路からバッテリに電力を供給するときには、チョッパ回路を降圧用チョッパとして作用可能であるので、モータを回生制動する場合若しくはバッテリを外部電源より充電する場合にモータ発電電圧若しくは外部電源電圧がバッテリ電圧よりも高かったとしても、回路素子を破損することなくバッテリに充電することができる。

【００２８】請求項３記載のモータの駆動装置によれば、モータの回生制動時にモータ発電電圧がバッテリ電圧より低い場合には、駆動回路のアームの負側スイッチング素子をオンオフ制御することにより、そのアームが昇圧用チョッパとして作用するようになる。

【００２９】請求項４記載のモータの駆動装置によれば、バッテリの充電時に、外部の交流電源は全波整流回路により全波整流されるとともに、その全波整流電圧は１つのアームが昇圧用チョッパとして作用して昇圧されるようになり、従って、交流電源電圧がバッテリ電圧より低い場合でもバッテリの充電が可能になる。

【００３０】請求項５記載のモータの駆動装置によれば、制御手段は、交流側電流検出手段の検出電流に基づいて全波整流回路のサイリスタの通電位相を略零から徐々に大となるように制御するので、充電開始時の突入電流を抑制することができる。

【００３１】請求項６記載のモータの駆動装置によれば、バッテリの充電時に、制御手段は、直流側電流検出手段の検出電流に基づいて降圧用チョッパとして作用するチョッパ回路のオンデューティを徐々に上昇させるので、充電電流を所定値に制御することができ、安定した充電を行なわせることができる。

【００３２】請求項７記載のモータの駆動装置によれば、バッテリの充電時に、制御手段は、直流側電流検出手段の検出電流が所定値に達しない場合には、昇圧用チョッパのオンオフデューティを調整して充電電流を制御するので、請求項６と同様の効果を奏する。

【００３３】請求項８記載のモータの駆動装置によれば、スイッチング回路と双方向三端子サイリスタを設けるようにしても、請求項５と同様の作用効果が得られる。請求項９及び１０に記載のモータの駆動装置によれば、基準信号に外部交流電源から流れる電流を追従させるので、力率改善を図ることができ、又、コンデンサに交流電源電圧のピーク値以上の電圧に充電するので、降圧用チョッパとの作用によりバッテリの充電電流が一定となるように制御することができる。

【００３４】請求項１１記載のモータの駆動装置によれば、コンデンサの端子間電圧がバッテリの充電電圧よりも高い場合にもチョッパ回路を降圧用チョッパとして作用させるので、請求項１０と同様の効果が得られる。

【００３５】請求項１２記載のモータの駆動装置によれば、モータの最も頻繁に使用される出力において、バッテリの基準電圧が駆動回路のＰＷＭデューティが１００％となる状態でモータに印加されるので、モータ及び駆動回路を定常出力に応じて設計することができる。

【００３６】請求項１３記載のモータの駆動装置によれば、バッテリのリフレッシュ動作時にその残存エネルギーを交流電源に回生させるので、エネルギー効率がよくなり、放電用抵抗器は不要となる。請求項１４に記載のモータの駆動装置によれば、チョッパ回路をトランジスタモジュールにて構成したので、構成が簡単になる。

【００３７】請求項１５記載のモータの駆動装置によれば、モータに、鉄を含んでなる永久磁石によって構成されたロータを用いても、ロータの鉄損による温度上昇を抑制することができる。

【００３８】

【実施例】以下、本発明を電気自動車に適用した第１の実施例につき、図１乃至図５を参照しながら説明する。全体構成を示す図１において、電気自動車には、走行用のモータとしてインダクションモータ１１が搭載されており、これは、複数相例えば３相のステータコイル１２Ｕ，１２Ｖ及び１２Ｗを有するステータ１２と、図示しないロータとを備えている。又、電気自動車には、ニッケル系電池からなる充電可能なバッテリ１３が搭載されており、このバッテリ１３からの直流電源がバッテリ充電装置及びバッテリリフレッシュ装置兼用モータ駆動装置１４によって交流電源に変換されて前記インダクションモータ１１に供給されるようになっている。

【００３９】さて、バッテリ充電装置及びバッテリリフレッシュ装置兼用モータ駆動装置１４の具体的構成につき、述べる。駆動回路としてのインバータ回路１５は、６個のスイッチング素子たるＮＰＮ形のトランジスタ１６Ｕ，１６Ｖ，１６Ｗ及び１７Ｕ，１７Ｖ，１７Ｗを３相ブリッジ接続して構成されたもので、夫々のコレクタ，エミッタ間には、フライホイールダイオード１８Ｕ，１８Ｖ，１８Ｗ及び１９Ｕ，１９Ｖ，１９Ｗが接続され、以て、３つのアーム２０Ｕ，２０Ｖ及び２０Ｗを有する。そして、このインバータ回路１５の入力端子２１ａ，２１ｂは、線間にコンデンサ２２が接続された直流母線２３，２４に接続され、出力端子２５Ｕ，２５Ｖ及び２５Ｗは、インダクションモータ１１のステータコイル１２Ｕ，１２Ｖ及び１２Ｗの各一端子に接続されている。尚、ステータコイル１２Ｕ，１２Ｖ及び１２Ｗの各他端子は共通に接続されている。



【００４０】チョッパ回路２６は、スイッチング素子としてのＮＰＮ形のトランジスタ２７，２８及びフライホイールダイオード２９，３０を有するトランジスタモジュールにて構成されたもので、そのトランジスタ２７において、コレクタは直流母線２３に接続され、エミッタはトランジスタ２８のコレクタに接続されており、そのトランジスタ２８のエミッタは直流母線２４に接続されており、トランジスタ２７及び２８の各コレクタ，エミッタ間にはダイオード２９及び３０が接続されている。そして、チョッパ回路２６の中性点たる交流電源端子３１は直流側リアクトル３２を介してバッテリ１３の正端子に接続されており、バッテリ１３の負端子は直流母線２４に接続されている。

【００４１】インバータ回路１５の１つのアーム２０Ｕの中性点たる出力端子２５Ｕは、全波整流回路３３の正直流出力端子に接続されており、その全波整流回路３３の負直流出力端子は、直流母線２４（バッテリ３の負端子）に接続されている。この場合、全波整流回路３３は、２個のサイリスタ３３ａ，３３ｂと２個のダイオード３３ｃ，３３ｄをブリッジ接続して構成されたもので、その交流入力端子は一方側に交流側リアクトル３４を挿入した交流電源ライン３５及び３６を介して差込みプラグ３７に接続されている。

【００４２】直流電圧検出器３８は、バッテリ１３の正，負端子間に接続されていて、バッテリ１３の端子間電圧を検出するようになっている。交流側電流検出手段たる交流電流検出器３９は、交流電源ライン３６に配設されていて、交流電源ライン３６に流れる電流（後述するようにリアクトル３４に流れる電流）を検出するようになっている。直流側電流検出手段たる充電電流検出器４０は、直流母線２４に配設されていて、バッテリ１３に流れる充電電流を検出するようになっている。尚、交流電流検出器３９及び充電電流検出器４０は、交流電流及び直流電流のいずれも検出し得るホール素子形変流器によって構成されている。フォトカプラからなるゼロクロス点センサ４１は、直流電源ライン３５，３６間に設けられている。

【００４３】さて、制御手段たる制御回路４２は、マイ

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クロコンピュータを主体として構成されたもので、その各入力ポートに直流電圧検出器３８，交流電流検出器３９，充電電流検出器４０及びゼロクロス点センサ４１の各出力端子が接続され、各出力ポートがインバータ回路１５のトランジスタ１６U乃至１６W，１７U乃至１７W及びチョッパ回路２６のトランジスタ２７，２８のベース（ゲート）に夫々接続されている。尚、マイクロコンピュータ４２の２つの出力ポートは、図示はしないが、全波整流回路３３のサイリスタ３３ａ，３３ｂのゲートに接続されている。

【００４４】次に、本実施例の作用につき、図２乃至図５をも参照して説明する。

（１）インダクションモータ１１の駆動

先ず、電気自動車の走行時の動作を述べる。即ち、制御回路４２は、インバータ回路１５のトランジスタ１６U乃至１６W及び１７U乃至１７Wに対する通電タイミング信号を作成し、その通電タイミング信号に応じてトランジスタ１６U乃至１６W及び１７U乃至１７Wにベース信号（ゲート信号）を所定の順序で与えて、そのトランジスタ１６U乃至１６W及び１７U乃至１７Wをオンオフ制御する。これにより、インバータ回路１５は、バッテリ１３の直流電圧から交流電圧を作成してインダクションモータ１１に与えるようになり、インダクションモータ１１が回転し、電気自動車が走行する。

【００４５】ここで、モータ定格として、定常時（頻繁に使用する回転数及びトルク）は１６０（V），１０（KW）即ち、５０００（ｒｐｍ），２０（N・m）とし、最大出力時は３２０（V），４０（KW）即ち１００００（ｒｐｍ），４０（N・m）が必要であるとした場合、インダクションモータ１１として、図２に示すように、５０００（ｒｐｍ），２０（N・m）のものを準備し、バッテリ１３として１６０（V）のものを選定する。

【００４６】インダクションモータ１１を定常時たる５０００（ｒｐｍ）で回転させる場合には、制御回路４２は、チョッパ回路２６のトランジスタ２７及び２８をオフさせたままとなる。従って、コンデンサ２２は、端子間電圧がバッテリ電圧１６０（V）になるように充電され、これがインバータ回路１５に印加される。そして、制御回路４２は、インダクションモータ１１が５０００（ｒｐｍ）で回転するようにインバータ回路１５のトランジスタ１６U乃至１６W及び１７U乃至１７Wをオンオフ制御するようになるが、このときのＰＷＭデューティは１００（%）に設定する。従って、インダクションモータ１１に印加される電圧は１６０（V）になる。

【００４７】インダクションモータ１１を５０００（ｒｐｍ）よりも低い回転数で回転させる場合には、制御回路４２は、インバータ回路１５のトランジスタ１６U乃至１６W若しくは１７U乃至１７WをＰＷＭ制御することによって、インダクションモータ１１に印加される電圧がその回転数に応じた低い電圧となるように制御する。

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【００４８】インダクションモータ１１を５０００（ｒｐｍ）よりも高い回転数で回転させる場合には、制御回路４２は、先ず、チョッパ回路２６のトランジスタ２８をオンさせる。これにより、バッテリ１３の正端子，リアクトル３２，トランジスタ２８及びバッテリ１３の負端子の経路でリアクトル３２に電流が流れることにより電磁エネルギーが蓄積される。その後、制御回路４２は、チョッパ回路２６のトランジスタ２８をオフするようになり、リアクトル３２に蓄積された電磁エネルギーはフライホイールダイオード２９を介してコンデンサ２２に蓄積され、コンデンサ２２の端子間電圧は１６０（V）よりも高い電圧になる。

【００４９】例えば、インダクションモータ１１の回転数を７５００（ｒｐｍ）にさせる場合には、チョッパ回路２６のトランジスタ２８のオンオフデューティを制御することにより、コンデンサ２２の端子間電圧が２４０（V）となるように昇圧する。又、インダクションモータ１１の回転数を最大出力たる１００００（ｒｐｍ）にさせる場合には、同じく、チョッパ回路２６のトランジスタ２８のオンオフデューティを制御することにより，コンデンサ２２の端子間電圧が３２０（V）となるように昇圧する。

【００５０】即ち、チョッパ回路２６は昇圧用チョッパとして作用するもので、このチョッパ回路２６が昇圧用チョッパとして作用しているときには、制御回路４２は、インバータ回路１５のトランジスタ１６U乃至１６W若しくは１７U乃至１７WのＰＷＭデューティを１００（%）とするように制御するようになっている。従って、インダクションモータ１１には、チョッパ回路２６により昇圧されたコンデンサ２２の端子間電圧がインバータ回路１５を介して印加されるようになる。

【００５１】（２）インダクションモータ１１の回生制動

インダクションモータ１１が高出力（高回転数）から低出力（低回転数）に移行する場合には、インダクションモータ１１は回生制動となる。即ち、制御回路４２は、チョッパ回路２６のトランジスタ２７をオンさせるようになり、従って、インダクションモータ１１からの回生電流は、インバータ回路１５のフライホイールダイオード１８U乃至１８W及び１９U乃至１９W並びにチョッパ回路２６のトランジスタ２７を介してバッテリ１３に流れるようになる。

【００５２】この場合、インダクションモータ１１の発電電圧は、このときの回転数に比例するようになるので、モータ発電電圧がバッテリ電圧の１６０（V）よりも高くなる。そこで、制御回路４２は、この回生制動時には、充電電流検出器４０によりバッテリ１３に対する充電電流（回生電流）Ｉｂを検出して、これが所定値を

超えるときには、チョッパ回路２６のトランジスタ２７をオフさせ、逆に、充電電流Ｉｂが所定値以下のときにはトランジスタ２７をオンさせるように制御する。従って、この場合には、チョッパ回路２６は降圧用チョッパとして作用するようになる。

【００５３】尚、インダクションモータ１１の回生制動時において、インダクションモータ１１の発電電圧がバッテリ１３の充電電圧たる１６０（Ｖ）よりも低い場合には、制御回路４２は、インバータ回路１５のアーム２０Ｕ乃至２０Ｗのいずれかの負側のトランジスタ１７Ｕ乃至１７Ｗをオンさせ、その後、そのトランジスタ１７Ｕ乃至１７Ｗをオフさせることを繰返してインバータ回路１５からバッテリ１３へ供給される電圧を昇圧する。従って、インバータ回路１５は、昇圧用チョッパとして作用するようになる。

【００５４】（３）バッテリ１３の充電

バッテリ１３が放電して電圧が降下すると、インダクションモータ１１を駆動するのに必要な電力が得られなくなるので、この場合には、バッテリ１３に外部の交流電源から充電する。即ち、差込みプラグ３７を外部の交流電源としての１００（Ｖ）の商用電源たる電源コンセント（図示せず）に差込み接続すると、制御回路４２は、自動的に充電モードに切換わり、この充電モードでは、インバータ回路１５の１つのアーム２０Ｕ，チョッパ回路２６及び全波整流回路３３を用いる。

【００５５】即ち、差込みプラグ３７が電源コンセントに差込み接続されると、ゼロクロス点センサ４１は、図４（ａ）及び図５（ａ）で示すように、交流電源電圧Ｖａｃが供給されて、図５（ｂ）で示すように、正（＋）半波でロウレベル及び負（－）半波でハイレベルとなる矩形波の出力信号Ｓを出力し、これを制御回路４２に与える。制御回路４２は、ゼロクロス点センサ４１からの出力信号Ｓがロウレベル，ハイレベルを繰返すことを検出すると、充電開始であると判断し、インバータ回路１５の１つのアーム２０Ｕのトランジスタ１７Ｕ及びチョッパ回路２６のトランジスタ２７以外のトランジスタ１６Ｕ乃至１６Ｗ及び１７Ｖ，１７Ｗをオフさせる。更に、制御回路４２は、図５（ｂ）に示すように、ゼロクロス点センサ４１からの出力信号Ｓの立上り及び立下がりから交流電源電圧Ｖａｃのゼロクロス点を検出する。

【００５６】制御回路４２は、交流電源電圧Ｖａｃのゼロクロス点を検出すると、これに基づきＰＬＬ制御により、図５（ｃ）に示すように、交流電源電圧Ｖａｃに同期した正弦波の基準（電圧）信号ＶＲを作成する。制御回路４２は、基準信号ＶＲから交流電源電圧Ｖａｃの極性を判断するようになっており、これに基づいて以下のような制御を行なう。

【００５７】制御回路４２は、外部の交流電源による充電と判断した場合には、初期充電動作を開始する。即ち、制御回路４２は、交流電源電圧Ｖａｃの正（＋）半波及び負（－）半波の双方において、チョッパ回路２６のトランジスタ２７をオンさせ、１つのアーム２０Ｕのトランジスタ１７Ｕをオンさせる。制御回路４２は、先ず、交流電源電圧Ｖａｃ（図４（ａ）参照）が負半波から正半波へのゼロクロス点近傍で全波整流回路３３のサイリスタ３３ｂにゲート信号を与えるようになり、従って、サイリスタ３３ｂの通電位相は、図４（ｂ）に示すように、略零となる。その後、制御回路４２は、図４（ｂ）に示すように、サイリスタ３３ａ及び３３ｂの通電位相が徐々に大になるようにそのサイリスタ３３ａ及び３３ｂに与えるゲート信号を制御するようになる。



【００５８】而して、サイリスタ３３ａ若しくは３３ｂがオンしている期間においては、リアクトル３４に電流が流れてリアクトル３４に電磁エネルギーが蓄積され、サイリスタ３３ａ若しくは３３ｂにゲート信号が与えられなくなり且つそのゲート信号に同期してトランジスタ１７Ｕがオフすると、その電磁エネルギーがコンデンサ２２を介してバッテリ１３に与えられるようになって、バッテリ１３が昇圧された電圧で充電されるようになり、従って、外部の交流電源の交流電源電流Ｉａｃは、図４（ｃ）に示すように、徐々に増加する。尚、バッテリ１３に対する充電の原理は、後に詳述する。バッテリ１３に対する充電電流Ｉｂは充電電流検出器４０によって検出されて制御回路４２に与えられるようになっており、制御回路４２は、充電電流Ｉｂが所定値に達すると、次の通常充電動作に移行する。

【００５９】即ち、制御回路４２は、交流電源電圧Ｖａｃが正（＋）半波の場合には、先ず、インバータ回路１５の１つのアーム２０Ｕのトランジスタ１７Ｕをオンさせ、且つ、全波整流回路３３のサイリスタ３３ｂをオンさせる。これにより、サイリスタ３３ｂ，トランジスタ１７Ｕ，ダイオード３３ｃ及びリアクトル３４の経路でリアクトル３４に交流電源電流Ｉａｃが流れ、リアクトル３４に電磁エネルギーが蓄積される。このリアクトル３４に流れる交流電源電流Ｉａｃは交流電流検出器３９により検出されて検出電流Ｉｄとして制御回路４２に与えられる。尚、検出電流Ｉｄは、実際には電圧に変換されて制御回路４２に与えられるものであるが、ここでは、説明の便宜上、検出電流Ｉｄとして述べる。

【００６０】トランジスタ１７Ｕのオン状態の継続により検出電流Ｉｄが増加してこれが基準信号ＶＲより大になると、制御回路４２は、トランジスタ１７Ｕをオフさせ、トランジスタ２７をオンさせる。これにより、リアクトル３４に蓄積された電磁エネルギーはサイリスタ３３ｂ及びフライホイールダイオード１８Ｕを介してコンデンサ２２に与えられ、更に、トランジスタ２７を介してバッテリ１３に与えられるようになり、バッテリ１３が昇圧された電圧で充電される。

【００６１】その後、交流電流検出器３９の検出電流Ｉｄが減少して基準信号ＶＲより小になると、制御回路４

２は再びトランジスタ１７Ｕをオンさせるようになる。以下、同様の動作を繰返すようになる。従って、トランジスタ１７Ｕに与えられるゲート信号Ｓｙは図５（ｄ）に示すようになる。

【００６２】交流電源電圧Ｖａｃが負（－）半波の場合には、制御回路４２は、１つのアーム２０Ｕのトランジスタ１７Ｕをオンさせ、且つ、サイリスタ３３ａをオンさせる。この場合のトランジスタ１７Ｕ及び２７のオンオフ動作は、前述と同様である。従って、トランジスタ１７Ｕに与えられるゲート信号Ｓｚは図５（ｅ）に示すようになる。

【００６３】即ち、制御回路４２は、図５（ｆ）に示すように、検出電流Ｉｄが基準信号ＶＲに追従するようにトランジスタ１７Ｕをオンオフ制御するものであり、これにより、検出電流Ｉｄは交流電源電圧Ｖａｃと同相の正弦波状の波形に制御され、交流電源電流Ｉａｃは図５（ｇ）に示すようになる。

【００６４】而して、バッテリ１３の端子間電圧は直流電圧検出器３８によって検出されて制御回路４２に与えられるようになっており、制御回路４２は、バッテリ１３の端子間電圧が規定値に達すると、充電完了と判断してトランジスタ１７Ｕ，２７及びサイリスタ３３ａ，３３ｂをオフさせ、図示しない報知器を動作させて充電完了を報知する。

【００６５】このように、本実施例によれば、インダクションモータ１１を駆動する場合には、チョッパ回路２６を昇圧用チョッパとして作用させ、且つ、インバータ回路１５をＰＷＭ制御するようにしたので、インダクションモータ１１としては、定常運転時の定格にすることができて、効率をよくすることができる。又、インダクションモータ１１の回生制動時には、インダクションモータ１１の発電電圧に応じてチョッパ回路２６を降圧用チョッパとして作用させ、若しくは、インバータ回路１５を昇圧用チョッパとして作用させるようにしたので、インダクションモータ１１の回生制動を円滑に行なうことができる。

【００６６】更に、バッテリ１３の充電時には、駆動回路たるインバータ回路１５の１つのアーム２０Ｕの出力端子２５Ｕとバッテリ１３の負端子との間にリアクトル３４を介して外部の交流電源を接続し、トランジスタ１７Ｕ及び２７の双方をオンオフ制御するようにしたので、リアクトル３４に外部の交流電源から断続的に電流が流れて電磁エネルギーが蓄積され、その電磁エネルギーが１つのアーム２０Ｕ及びチョッパ回路２６を介してバッテリ１３に与えられてこれが充電されるようになる。

【００６７】従って、従来とは異なり、重量及び体積の大なるトランスを有する専用の充電器を用いなくても、チョッパ回路２６を追設して制御回路４２の制御だけでバッテリ１３の充電を行なうことができ、その分だけ、製造コストの低減を図り得、又、電気自動車の機械室における搭載物の小型軽量化を図り得て、一充電走行距離を長くすることがてき、逆に、小型軽量化を図った分だけバッテリ１３の個数を多く搭載することができるので、一充電走行距離を長くすることができる。又、１６０（Ｖ）定格のバッテリ１３に対してこれよりも低い電圧若しくは高い電圧の外部電源であっても、そのバッテリ１３に容易に充電することができるものであり、使用者にとって極めて有利である。

【００６８】更に、バッテリ１３の充電時において、外部電源が交流電源の場合には、制御回路４２は、ゼロクロス点センサ４１の出力信号に基づいて交流電源電圧Ｖａｃのゼロクロス点を検出して、これに基づいて交流電源電圧Ｖａｃに同期した基準信号ＶＲを得、この基準電圧ＶＲに交流電源電流Ｉａｃを検出する交流電流検出器３９の検出電流Ｉｄを追従させるようにした。

【００６９】従って、昇圧用リアクトル３４を用いても交流電源の力率改善の制御を行なうことができ、電源高調波の低減を図ることができ、又、同時にバッテリ１３に対する充電電流の制御も行なうことができる。

【００７０】又、制御回路４２は、バッテリ１３の充電時においては、バッテリ１３の充電路に設けられた全波整流回路３３のサイリスタ３３ａ若しくは３３ｂの通電位相を略零から徐々に大になるように制御する初期充電動作をおこなわせるようにしたので、バッテリ１３に対する急激な充電を防止することができて、バッテリ１３に悪影響を及ぼすことがない。

【００７１】尚、上記実施例において、バッテリ１３の充電時に、コンデンサ２２にバッテリ電圧たる１６０（Ｖ）以上の電圧（例えば３００（Ｖ））に充電し、チョッパ回路２６のトランジスタ２７を、交流電流検出器３９若しくは充電電流検出器４０の検出電流に基づくオンオフデューティにて調整してバッテリ１３の充電電流を一定にするようにしてもよい。

【００７２】図６及び図７は本発明の第２の実施例であり、図１と同一部分には同一符号を付して示し、以下、異なる部分のみを説明する。即ち、直流母線２３，２４間には、スイッチング回路４３が接続されており、このスイッチング回路４３は、フライホイールダイオード４６，４７を並列に有するスイッチング素子たるＮＰＮ形のトランジスタ４４，４５を直列に接続して構成されている。そして、インバータ回路１５の１つのアーム２０Ｕの中性点たる出力端子２５Ｕは、双方向性三端子サイリスタ（以下、トライアックと称す）４８を介して交流電源ライン３５に接続され、スイッチング素子４３の中性点たる交流電源端子４８は、交流電源ライン３６に接続されている。

【００７３】図７において、直流モータ４９の回転軸４９ａには、ウォーム４９ｂが形成され、可動接点板５０には、そのウォーム４９ｂと噛合するウォームギア５０

aが設けられ、可動接点板５０の接点部５０ｂ及び５０ｃは、固定接点板５１及び５２の接点部５１ａ及び５２ａにその上下動により接離するようになっており、以上により、コンタクタ５３が構成されている。

【００７４】そして、直流電源たる電池５４の正端子は、切換スイッチ５５の固定接片ａ及び切換スイッチ５６の固定接片ｂに接続され、電池５４の負端子は、切換スイッチ５５の固定接片ｂ及び切換スイッチ５６の固定接片ａに接続されており、切換スイッチ５５及び５６の可動接片ｃ，ｃは直流モータ４９の入力端子に接続されている。

【００７５】再び、図６において、コンタクタ５３の固定接点板５１はバッテリ１３の正端子に接続され、固定接点板５２は直流側リアクトル３２のバッテリ側端子に接続されている。

【００７６】而して、インダクションモータ１１の駆動及びインダクションモータ１１の回生制動並びにバッテリ２２の充電の動作については、全波整流回路３３のサイリスタ３３ａ，３３ｂの代わりにトライアック４８が行なうようになる以外は、第１の実施例と同様である。

【００７７】（４）バッテリ１３のリフレッシュ

さて、バッテリ１３のリフレッシュ動作について述べるに、このときには差込みプラグ３７を例えば単相１００ボルトの交流電源たる電源コンセントに差込み接続し、図示しないリフレッシュスイッチを操作してオンさせる。これにより、制御回路４２は、インダクションモータ１１の駆動モードからバッテリ１３のリフレッシュモードへと切換わる。

【００７８】差込みプラグ３７が電源コンセントに接続されると、ゼロクロス点センサ４１は、前述したように、出力信号Ｓを出力し、これにより、制御回路４２は、ＰＬＬ制御により、図５（ｃ）に示すように、交流電源電圧Ｖａｃに同期した正弦波の基準（電圧）信号ＶＲを作成し、制御回路４２は、基準信号ＶＲから交流電源電圧Ｖａｃの極性を判断するようになっており、これに基づいて以下のような制御を行なう。

【００７９】制御回路４２は、リフレッシュモードでは、インバータ回路１５の１つのアーム２０Ｕ，スイッチング回路４３及びトライアック４８を用いる。即ち、制御回路４２は、トライアック４８をオンさせるとともに、交流電源電圧Ｖａｃが正（＋）半波の場合には、先ず、１つのアーム２０Ｕのトランジスタ１６Ｕ及びスイッチング回路４３のトランジスタ４５をオンさせる。これにより、バッテリ１３の正端子，コンタクタ５３，ダイオード２９，トランジスタ１６Ｕ，トライアック４８，コンセント３７（交流電源），リアクトル３４，トランジスタ４５及びバッテリ１３の負端子の経路で交流電流（バッテリ１３の放電電流，交流電源への回生電流）が流れ、これは交流電流検出器３９により検出されて検出電流として制御回路４２に与えられる。



【００８０】トランジスタ１６Ｕ及び４５のオン状態の継続により検出電流が増加してこれが基準信号ＶＲよりも大となると、制御回路４２は、トランジスタ１６Ｕをオフさせる。その後、交流電流検出器３９の検出電流が減少して基準信号ＶＲより小になると、制御回路４２は再びトランジスタ１６Ｕをオンさせるようになる。以下、同様の動作を繰返すようになる。

【００８１】交流電源電圧Ｖａｃが負（－）半波の場合には、制御回路４２は、１つのアーム２０Ｕのトランジスタ１７Ｕをオンさせるとともに、スイッチング回路４３のトランジスタ４４をオンさせる。この場合のトランジスタ４４のオンオフ動作は、前述のトランジスタ１６Ｕと同様である。

【００８２】このように第２の実施例によれば、バッテリ１３のリフレッシュ動作時には、インバータ回路１５の１つのアーム２０Ｕとスイッチング回路４３とによって形成される降圧用チョッパにより、バッテリ１３の残存電力（残存エネルギー）を外部の交流電源に回生するようにしたので、従来とは異なり、放電用抵抗器を用いてジュール熱として放散させる必要はなくなり、それだけ、エネルギー効率の改善を図ることができ、又、放電用抵抗器が不要であるので、電気自動車内にその設置スペースを確保する必要がなく、設置スペースの狭い電気自動車には最適である。

【００８３】尚、バッテリ１３を電気自動車から取外す場合には、例えば、切換スイッチ５５及び５６の接片（ｃ－ａ）間をオンさせて直流モータ４９を一方向に回転させることにより、可動接点板５０を上昇させて、図７に示すように、コンタクタ５３をオフさせ、逆に、バッテリ１３を電気自動車に設置する場合には、切換スイッチ５５及び５６の接点（ｃ－ｂ）間をオンさせて直流モータ４９を逆方向に回転させることにより、可動接点板５０を下降させて、コンタクタ５３をオンさせる。これにより、コンタクタ５３を、振動等によりチャタリングのない安定したスイッチ手段となし得る。

【００８４】図８及び図９は本発明の第３実施例であり、図１と同一部分には同一符号を付して示し、以下、異なる部分について説明する。即ち、この第３実施例では、モータとしてブラシレスモータ５７を用いたもので、ブラシレスモータ５７は、複数相例えば３相のステータコイル５８Ｕ，５８Ｖ及び５８Ｗを有するステータ５８と、鉄を含んだ磁性体、例えば、ネオジウム－鉄－ホウ素（Ｎｄ－Ｆｅ－Ｂ）からなる磁性体を用いた永久磁石形のロータ（図示せず）とから構成されている。そして、ステータコイル５８Ｕ，５８Ｖ及び５８Ｗは、スター結線され、その各一端子はインバータ回路１５の出力端子２５Ｕ，２５Ｖ及び２５Ｗに接続されている。

【００８５】而して、ブラシレスモータ５７には、周知のように、ロータの回転位置を検出するホール素子等からなる３個の位置検出素子が設けられており、制御回路

４２は、これらの位置検出素子からの位置検出信号を論理演算することによりインバータ回路１５のトランジスタ１６U乃至１６W及び１７U乃至１７Wに対する通電タイミング信号を作成するようになっている。制御回路４２のその他の動作は第１実施例と同様であり、従って、電気自動車の走行用モータとしてブラシレスモータ５７を用いた場合でも、前記第１実施例同様の効果を得ることができる。ところで、ブラシレスモータ５７のロータを、Ｎｄ－Ｆｅ－Ｂからなる磁性体を用いた永久磁石で構成すると、この種の永久磁石は保磁力が高いので、効率が良く且つ長寿命とし得る利点がある。

【００８６】この場合、従来（図１０）のモータ７としてブラシレスモータを用い、且つ、そのロータとして第３実施例のブラシレスモータ５７のロータと同様のものを用いると、従来例では、モータ７への印加電圧はＰＷＭ制御のみによって変化させるようにしていることから、印加電圧に含まれる高調波成分によりロータの永久磁石に含まれる鉄分による鉄損が大になって、ロータが著しく温度上昇する問題が生じる。

【００８７】これに対して、この第３実施例によれば、ブラシレスモータ５７を定常時の回転数以上で回転させるべくチョッパ回路２６が昇圧用チョッパとして作用するときには、制御回路４２は、インバータ回路１５のトランジスタ１６U乃至１６W若しくは１７U乃至１７WをＰＷＭデューティ１００（％）とするように制御するので、ＰＷＭ制御に基づく印加電圧の高調波成分によるロータの鉄損は著しく小さくなり、ロータの発熱を極力防止することができる。そして、ブラシレスモータ５７を定常時の回転数未満で回転させる場合でも、従来のＰＷＭデューティよりも高くすることができるので、ロータの高調波成分による鉄損を小さくすることができる。

【００８８】図９は、本発明者らの実験により得られたロータ温度特性を示すものである。尚、バッテリ１及び１３の電圧は共に３３０Ｖである。図９中に△でプロットされた温度特性Ａは、従来のモータの駆動装置によりモータ７を駆動して、電気自動車を８０ｋｍ／ｈで走行させた場合のモータ７のロータ温度特性である。モータ７の定格は、３３０（Ｖ），１００００（ｒｐｍ），１０（Ｎ・ｍ）であり、駆動時におけるモータの駆動装置の主回路電圧は３３０（Ｖ），ＰＷＭデューティは３０（％）である。尚、図９の横軸は時間（分），縦軸は温度（ｄｅｇ）である。

【００８９】また、図９中に×でプロットされた温度特性Ｂは、図８に示すようなモータ駆動装置１４によりブラシレスモータ５７を駆動して、電気自動車を８０ｋｍ／ｈで走行させた場合のブラシレスモータ５７のロータ温度特性である。ブラシレスモータ５７の定格は、６６０（Ｖ），１００００（ｒｐｍ），１０（Ｎ・ｍ）であり、駆動時におけるモータ駆動装置１４の主回路電圧は３３０（Ｖ），ＰＷＭデューティは６０（％）である。

【００９０】図９から明らかなように、温度特性Ｂは、温度特性Ａに比して時間経過に対する温度上昇が低く良好な特性を示している。これは、モータ駆動装置１４は、チョッパ回路２６を昇圧用チョッパとして作用させてインバータ回路１５の主回路電圧を昇圧できるので、バッテリ１３の電圧よりも高い定格電圧６６０（Ｖ）のブラシレスモータ５７を使用でき、これによって、従来と同一速度を得るのでＰＷＭデューティを高くすることができるからである。

【００９１】即ち、バッテリ１及び１３の電圧が同じである場合、定格電圧がブラシレスモータ７の２倍であるブラシレスモータ５７によって前者と同じ回転速度を得るには、ＰＷＭデューティを２倍にすれば良い。従って、ＰＷＭデューティが大きくなった分だけＰＷＭ信号に含まれる高調波成分は減少し、それに伴って、ブラシレスモータ５７のロータの永久磁石に鉄損によって生じる発熱は減少することになる。

【００９２】この鉄損による温度上昇の問題により、従来の駆動装置によってモータを駆動する場合、そのモータのロータには、例えばフェライトなどからなる永久磁石を用いるしか無かったが、以上のように第３実施例によれば、ブラシレスモータ５７のロータに鉄を含むＮｄ－Ｆｅ－Ｂからなる永久磁石を用いても、その永久磁石の鉄損による発熱を抑制することができる。従って、ロータの永久磁石に従来より保磁力の高い磁性材料を使用することが可能となり、ブラシレスモータ５７の効率を高めることができ、長寿命とすることができる。尚、上記実施例では、永久磁石の磁性体としてＮｄ－Ｆｅ－Ｂを用いたが、これに限ることなく、鉄を含む磁性体であれば何でも良い。

【００９３】また、上記実施例では、モータとしてインダクションモータ１１もしくはブラシレスモータ５７を用いるようにしたが、代わりに、２相モータ，ブラシ付直流モータ，或いはリラクタンスモータを用いてもよく、この場合には、駆動回路としてはフライホイールダイオードを有するスイッチング素子たるトランジスタを２個直列に接続してなる１つのアームしか有しないもの（例えばブラシ付直流モータ）もあり、従って、駆動回路としては１つ以上のアームを有するものが対象となる。

【００９４】更に、上記実施例では、電流制限用スイッチング素子としてトライアック４８を設けるようにしたが、代わりに、逆並列接続した２個のサイリスタを設けてもよく、或いは、逆並列接続した２個のフォトサイリスタ若しくはフォトトライアックを設けるようにしてもよい。

【００９５】その他、本発明は上記した実施例にのみ限定されるものではなく、例えば、電気自動車に限らずバッテリを電源としてモータを駆動するモータ駆動装置を必要とする装置全般に適用することができる等、要旨を

逸脱しない範囲内で適宜変形して実施し得ることは勿論である。

【００９６】

【発明の効果】本発明は、以上説明した通りであるので、次のような効果を奏する。請求項１及び２記載のモータの駆動装置によれば、バッテリから駆動回路を介してモータに電力を供給するときには、チョッパ回路を昇圧用チョッパとして作用可能であるので、バッテリ電圧よりも高い電圧をモータに印加することが可能になって、モータを定常時よりも高い回転数で駆動させることができ、定常運転時の効率をよくすることができる。又、駆動回路からバッテリに電力を供給するときには、チョッパ回路を降圧用チョッパとして作用可能であるので、モータを回生制動する場合若しくはバッテリを外部電源より充電する場合にモータ発電電圧若しくは外部電源電圧がバッテリ電圧よりも高かったとても、回路素子を破損することなくバッテリに円滑に充電することができる。

【００９７】請求項３記載のモータの駆動装置によれば、モータの回生制動時に、モータ発電電圧がバッテリ電圧より低い場合には、駆動回路のアームの負側スイッチング素子をオンオフ制御することにより、そのアームが昇圧用チョッパとして作用するようになる。

【００９８】請求項４記載のモータの駆動装置によれば、バッテリの充電時に、外部の交流電源は全波整流回路により全波整流されるとともに、その全波整流電圧は１つのアームが昇圧用チョッパとして作用して昇圧されるようになり、従って、バッテリの充電のために専用の充電器を設ける必要がなく、又、交流電源電圧がバッテリ電圧より低い場合でもバッテリの充電が可能になる。

【００９９】請求項５記載のモータの駆動装置によれば、制御手段は、交流側電流検出手段の検出電流に基づいて全波整流回路のサイリスタの通電位相を略零から徐々に大となるように制御するので、充電開始時の突入電流を抑制することができる。

【０１００】請求項６記載のモータの駆動装置によれば、バッテリの充電時に、制御手段は、直流側電流検出手段の検出電流に基づいて降圧用チョッパとして作用するチョッパ回路のオンオフデューティを徐々に上昇させるので、充電電流を所定値に制御することができ、安定した充電を行なわせることができる。

【０１０１】請求項７記載のモータの駆動装置によれば、バッテリの充電時に、制御手段は、直流側電流検出手段の検出電流が所定値に達しない場合には、昇圧用チョッパのオンオフデューティを調整して充電電流を制御するので、請求項６と同様の効果を奏する。

【０１０２】請求項８記載のモータの駆動装置によれば、スイッチング回路と双方向三端子サイリスタを設けるようにしても、請求項５と同様の作用効果が得られる。請求項９及び１０に記載のモータの駆動装置によれ



ば、基準信号に外部交流電源から流れる電流を追従させるので、力率改善を図ることができ、又、コンデンサに交流電源電圧のピーク値以上の電圧に充電するので、降圧用チョッパとの作用によりバッテリの充電電流が一定となるように制御することができる。

【０１０３】請求項１１記載のモータの駆動装置によれば、コンデンサの端子間電圧がバッテリの充電電圧よりも高い場合にもチョッパ回路を降圧用チョッパとして作用させるので、請求項１０と同様の効果が得られる。

【０１０４】請求項１２記載のモータの駆動装置によれば、モータの最も頻繁に使用される出力において、バッテリの基準電圧が駆動回路のＰＷＭデューティが１００％と成る状態でモータに印加されるので、モータ及び駆動回路を定常出力に応じて設計することができる。

【０１０５】請求項１３記載のモータの駆動装置によれば、バッテリのリフレッシュ動作時にその残存エネルギーを交流電源に回生させるので、エネルギー効率がよくなり、放電用抵抗器は不要となる。請求項１４に記載のモータの駆動装置によれば、チョッパ回路をトランジスタモジュールにて構成したので、構成が簡単になる。

【０１０６】請求項１５記載のモータの駆動装置によれば、モータに、鉄を含んでなる永久磁石によって構成されたロータを用いたので、モータの効率を高めることができ、且つ、長寿命とすることができつつ、ロータの温度上昇を極力防止することができる。

【図面の簡単な説明】

【図１】本発明の第１の実施例を示す電気的構成図

【図２】モータの特性図（その１）

【図３】モータの特性図（その２）

【図４】バッテリの充電時の各部の波形図（その１）

【図５】バッテリの充電時の各部の波形図（その２）

【図６】本発明の第２の実施例を示す図１相当図

【図７】コンタクタの構成図

【図８】本発明の第３実施例を示す図１相当図

【図９】ロータの温度特性を示す図

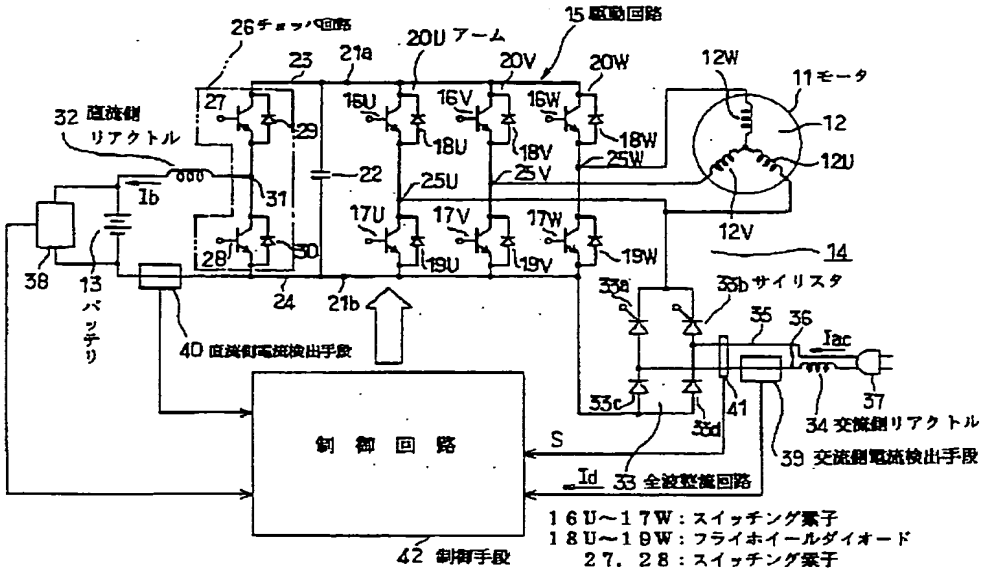
【図１０】従来例を示す電気的構成図

【符号の説明】

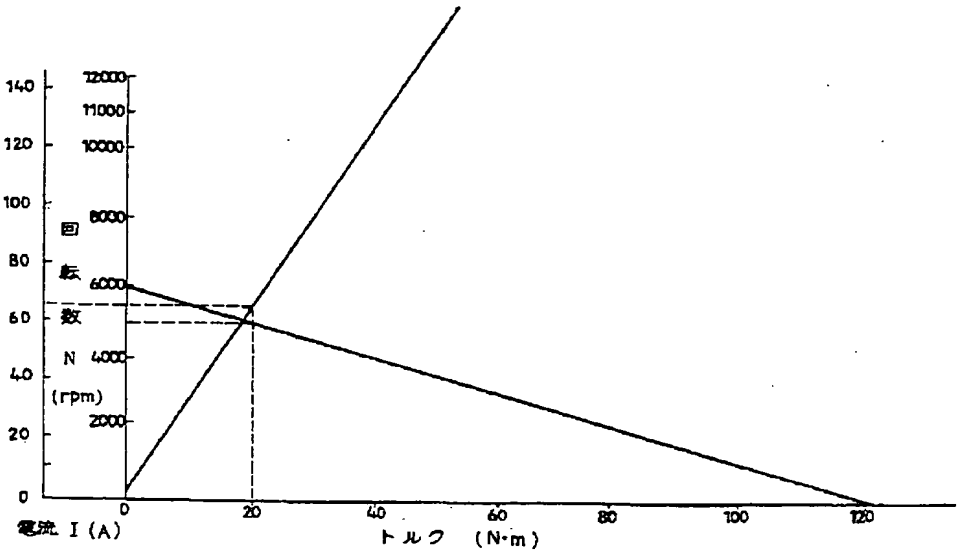
図面中、１１はインダクションモータ（モータ）、１３はバッテリ、１５はインバータ回路（駆動回路）、１６Ｕ乃至１６Ｗ及び１７Ｕ乃至１７Ｗはトランジスタ（スイッチング素子）、１８Ｕ乃至１８Ｗ及び１９Ｕ乃至１９Ｗはフライホイールダイオード、２０Ｕ乃至２０Ｗはアーム、２２はコンデンサ、２６はチョッパ回路、３２は直流側リアクトル、３３は全波整流回路、３３ａ及び３３ｂはサイリスタ、３４は交流側リアクトル、３８は直流電圧検出器、３９は交流電流検出器（交流側電流検出手段）、４０は充電電流検出器（直流側電流検出手段）、４１はゼロクロス点センサ、４２は制御回路（制御手段）、４３はスイッチング回路、４８は双方向性三端子サイリスタ、５７はブラシレスモータ（モータ）を

示す。

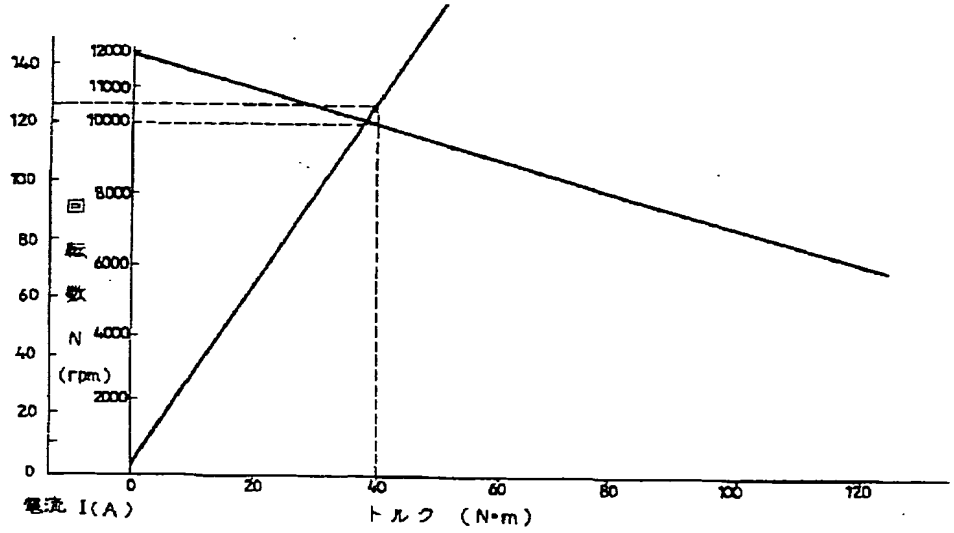
【図１】



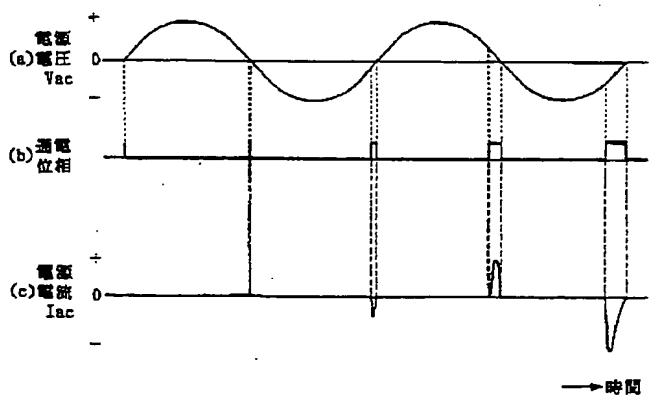

【図２】



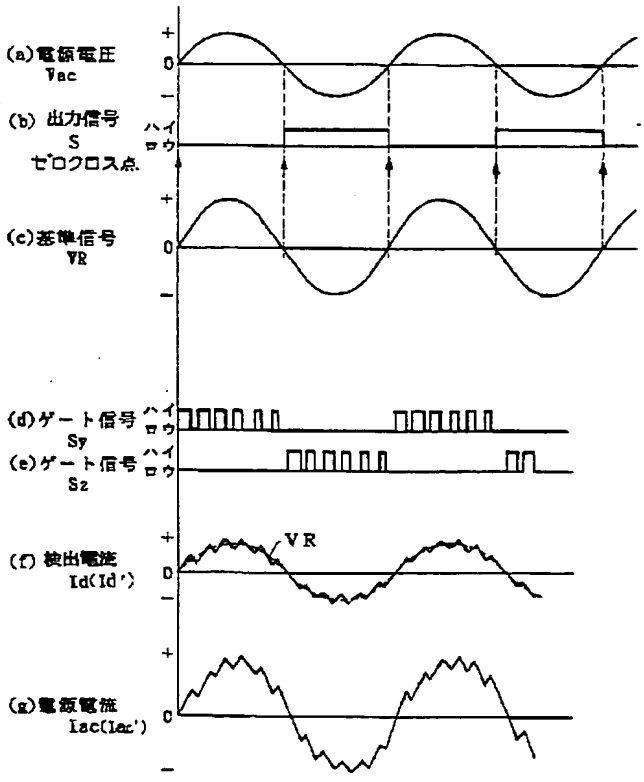
【図３】



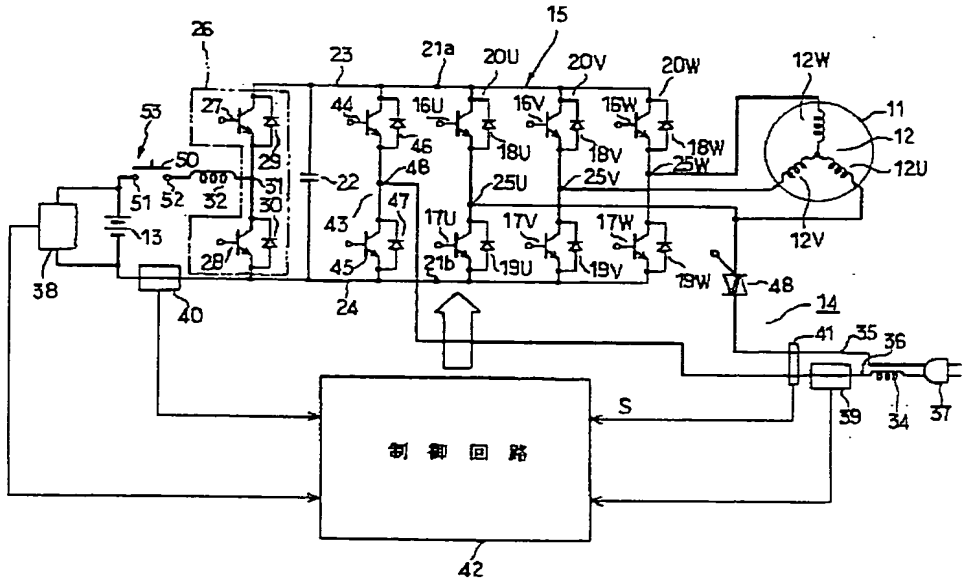

【図４】



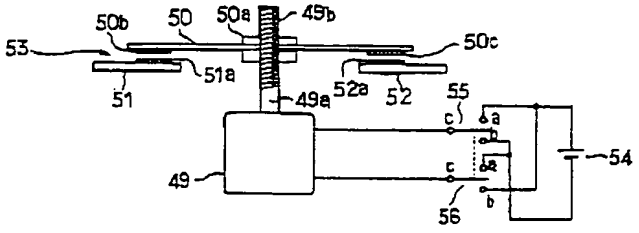

【図５】



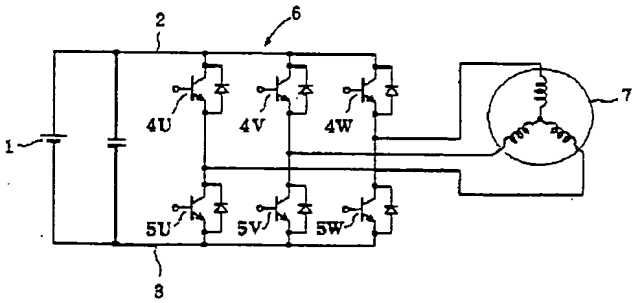
【図６】



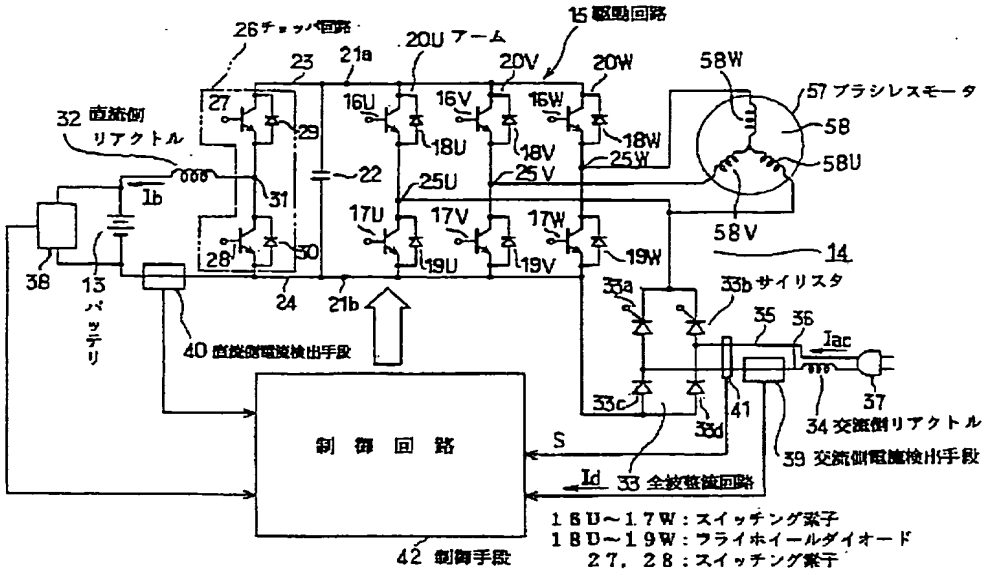

【図７】



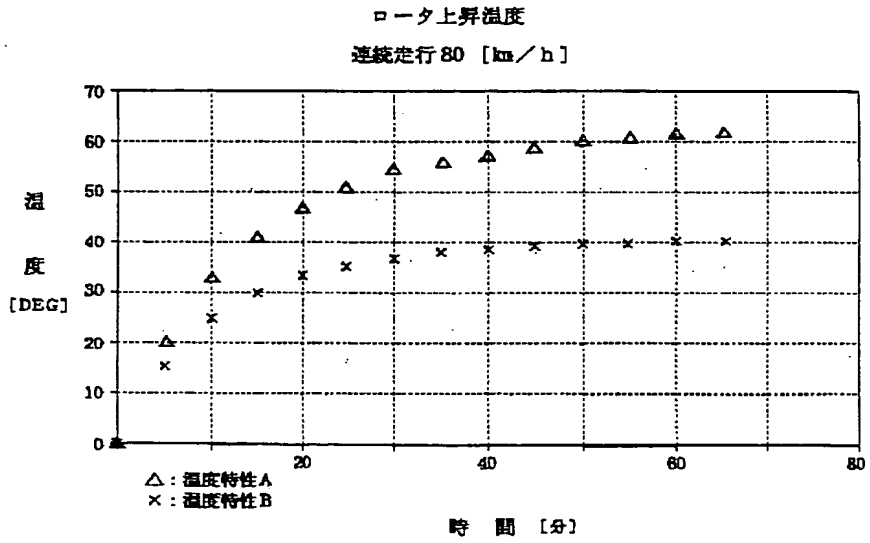
【図１０】



【図８】




【図９】

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